4. FOS Segment Requirements

Section 4 contains the set of FOS segment-wide requirements.

4.1 FOS Segment Requirements Overview

This section specifies the requirements which are allocated to the Flight Operations Segment. The segment-wide operational, functional, and performance, external interfaces, security, operational availability, and evolution requirements are included in this section.

This section is organized as follows:

4.2 Operational and Functional Requirements

This section specifies the FOS segment-level operational and functional requirements which describe how the segment is to work when built.

F-FOS-00010 The EOC shall use and support the Space Network (SN), via the EDOS/ Ecom interface, to obtain the forward and return link data communications needed to achieve full FOS functionality.

F-FOS-00015 The EOC shall use and support the Deep Space Network (DSN), the Ground Network (GN), and the Wallops Orbital Tracking Station (WOTS), via the EDOS/ Ecom/Nascom interface, as backup of the SN, to obtain forward and return link data communications.

F-FOS-00020 The EOC shall use and support the EDOS/Ecom interface to obtain the data formatting services, data distribution services, and data quality and accounting services needed to achieve full FOS functionality.

F-FOS-00025 The EOC shall use Ecom for flight operations data transfers.

F-FOS-00035 The EOC shall provide a test mode of operation that does not interfere with ongoing operations, and which supports independent FOS and subsystem

tests, end-to-end tests, and integration and verification activities occurring during at a minimum:

a. Spacecraft and instrument integration and test

b. Pre-launch

c. Upgrades and enhancements

F-FOS-00040 The EOC shall have the capability to schedule its systems and communications interfaces that are used for multiple spacecraft and instrument operations and for other activities, including maintenance, upgrade, sustaining engineering, testing, and training.

Note: The scheduling requirement will be implemented through operations at the EOC.

F-FOS-00045 The EOC shall participate in the scheduling of interface and end-to-end tests with the external elements involved, including the IP-ICCs, the spacecraft simulator(s), the SMC for other EOS elements, and EDOS for MO&DSD data delivery systems.

Note: The scheduling requirement will be implemented through operations at the EOC.

F-FOS-00070 The EOC shall manage initialization and shutdown of EOC functions.

F-FOS-00075 The EOC shall provide tests for validating, verifying, and checking functional capabilities and performance for EOC functions after the EOC has been repaired or upgraded.

F-FOS-00080 The EOC shall provide standard test data sets to be used in the validation of EOC function.

F-FOS-00085 The EOC shall support instrument integration activities associated with the spacecraft prior to launch.

F-FOS-00090 The EOC shall use simulations and test functions of the spacecraft simulator(s) to check out the EOC functions.

F-FOS-00095 The EOC shall support spacecraft and instrument tests at the integration site and at the launch site.

F-FOS-00098 The EOC shall provide the capabilities:

a. To test both nominal operations and failure paths

b. To log test activities and test configuration

c. To support analysis of test data and the generation of test results

d. To maintain test procedures and test results

F-FOS-00110 The EOC shall be capable of simultaneously supporting the Independent Verification and Validation (IV&V) activities and ECS development activities, both before and after flight operations begin.

F-FOS-00115 The EOC shall provide the following to be used in the revalidation of its functional performance:

a. Benchmark test(s)

b. Standard test data sets.

F-FOS-00120 The EOC shall provide access to the following items used in the checkout and verification process:

a. Stored test data sets

b. Stored test plans

c. Stored test procedures.

F-FOS-00125 The EOC shall be able to validate at any time during the life-time of the ECS that the EOC primary functional performance is consistent with pre?defined operational benchmark tests.

F-FOS-00130 The EOC shall be capable of verifying the fidelity of the EOC interface to:

a. Other ECS components at any time during the lifetime of the ECS

b. Entities external to ECS at any time during the lifetime of the ECS

F-FOS-00140 The EOC shall provide a set of real or simulated functions which interfaces with both ECS internal and external entities for use in the following types of test:

a. FOS Subsystems

b. EOC

c. ECS System (integration of ECS components)

d. EOSDIS System (Integration of EOSDIS components)

F-FOS-00145 The EOC shall support end-to-end EOS system testing and fault isolation.

F-FOS-00155 The EOC shall be capable of supporting end-to-end test and verification activities of the EOS program including during the pre-launch, spacecraft verification, and instrument verification phases.

F-FOS-00160 The EOC shall generate the following:

a. EOC security audit log

b. EOC resource utilization report

c. EOC anomaly report

d. EOC maintenance report

e. EOC hardware/software configuration history

F-FOS-00165 The EOC shall prepare a compliance report with the LTSP and LTIP.

Note: The compliance report with the LTSP and the LTIP will be manually prepared by the Flight Operations Team (FOT).

F-FOS-00170 The EOC shall provide the SMC with access to EOC reports, including at a minimum the following:

a. Plans and schedules

b. Security actions

c. Maintenance information

F-FOS-00175 The EOC shall administer the allocation of IST connections to the EOC.

Note: Allocation of IST connections will be administered based on the policy as defined in the IST Capabilities Document for the ECS Project (194-00602TPW).

F-FOS-00180 The EOC shall monitor IST connections for changes in status.

Note: The status monitored tells the EOC if the IST is logically connected to the EOC.

4.3 Performance Requirements

Segment-level performance requirements are specified in this section, including capacities, capabilities, and throughput. Note that individual subsystem-level performance requirements are included in the subsystem sections of this document.

F-FOS-00200 The ECS shall contribute a loop delay of not greater than 2.5 seconds of the total system delay of six (6) seconds for emergency real-time commands, not including the time needed for command execution.

Note: The loop delay is measured from the originator to the spacecraft/ instrument and back and only applies when a Tracking and Data Relay Satellite System (TDRSS) link is available for contact to the spacecraft.

Note: CSMS is providing the communication and networking services, which are part of the 2.5 seconds portion that ECS contributes to the total system delay.

F-FOS-00220 The EOC shall support the following simultaneous activities:

a. Performing mission coordination, planning, scheduling, monitoring, and commanding of the U.S. spacecraft and instruments as listed in Appendix D of the ECS Functional and Performance Specification.

b. At least two of the following: mission test activities, EOC system upgrades, training, and/or maintenance.

F-FOS-00225 The EOC computer hardware shall be able to grow without redesign to twice the processing, storage, and network communications capacities estimated for full system operation.

Note: The capacities specified herein are based on the operational profile for the FOS, which is included in Volume 2, Mission Specific Requirements, Section 4.3.1

Note: The communications services will be provided by CSMS.

F-FOS-00230 The EOC computer processing, storage, and network communications capacity utilization shall be less than 50 percent at turnover for operations.

Note: Reference 4.3.1 for the specific EOC System Capacity Requirements associated with each mission -- i.e., the definition of how the capacities will be measured for the mission.

F-FOS-00240 The EOC shall provide time resolution of 10 milliseconds for the internal EOC computer clocks.

Note: The time source is driven by an external source -- i.e., NASA-36 time.

F-FOS-00245 The EOC shall provide time accuracy of 500 milliseconds.

Note: The time accuracy pertains to the accuracy of the computer clocks in the EOC network with respect to one another and the time source.

F-FOS-00250 The FOS shall provide that the time lag between the production of an event message and its display does not exceed 1.0 second.

Note: This requirement is applicable during nominal operations -- i.e., it does not pertain to situations where a burst of limit violation messages are produced.

F-FOS-00255 The FOS shall provide a time accuracy for time tagging of event messages within 1 second of their occurrence.

Note: The test for this requirement will be by design inspection.

4.4 External Interfaces

EOC external interfaces refer to the interfaces between the EOC elements and the various ECS external elements including the supporting elements provided by the EOS project, NASA institutional facilities, and cooperating institutions, as well as the International Partners.

This section specifies the major segment-level external interface requirements. EOC external interfaces are discussed in the following subsections:

a. EOS Project – The external elements included in this category consist of the EOS spacecraft and instruments and the spacecraft simulators.

b. NASA Network and External elements – The external elements included in this category consist of the NASA networks (NSI and Ecom), NASA data systems and archives, the EDOS, the Flight Dynamics Facility (FDF), the Space Network (SN) (includes NCC), the Deep Space Network (DSN), Ground Network (GN), and Wallops Orbital Tracking System (WOTS).

4.4.1 EOS Project

Within the framework of applicable international agreements, the IWG will set overall mission priorities and the Program and Project scientists will confirm these priorities.

F-FOS-00300 The EOC shall interface with the EOS Project Scientist for resolution of conflicts between instrument activities of equal priority.

Note: This requirement will be fulfilled manually between the FOT and the Project Scientist.

F-FOS-00305 The EOC shall interface with the EOS spacecraft and with the EOS instruments in order to perform mission operations, including planning, scheduling, commanding, and monitoring functions.

F-FOS-00310 The EOC shall receive simulated spacecraft and instrument telemetry from the EOS spacecraft simulators.

Note: Reference the Interface Control Document between the EOC and Spacecraft Simulator for specifics pertaining to this interface.

F-FOS-00315 The EOC shall provide commands to the EOS spacecraft simulators.

Note: Reference the Interface Control Document between the EOC and Spacecraft Simulator for specifics pertaining to this interface.

F-FOS-00317 The EOC shall receive flight software loads from the Software Development and Validation Facility (SDVF).

Note: Reference the Interface Control Document between the EOC and SDVF for specifics pertaining to this interface.

F-FOS-00318 The EOC shall send flight software dumps to the Software Development and Validation Facility (SDVF).

Note: Reference the Interface Control Document between the EOC and SDVF for specifics pertaining to this interface.

4.4.2 Networks and NASA elements

F-FOS-00320 The EOC shall use Ecom for data communications for the following types of data:

a. Real-time telemetry data, rate-buffered telemetry data

b. Command data

c. TDRSS schedule requests and TDRSS schedules

d. Data exchange with the FDF, NCC and EDOS

Note: Reference the Interface Control Document between the EOC and Ecom for specifics pertaining to this interface.

Note: The communication and network services used by the EOC are provided by CSMS.

F-FOS-00325 The EOC shall receive EOS planning aids from the FDF.

Note: Reference the Interface Control Document between the EOC and FDF for specifics pertaining to this interface.

F-FOS-00330 The EOC shall provide the FDF with subsets of spacecraft housekeeping data.

Note: Reference the Interface Control Document between the EOC and FDF for specifics pertaining to this interface.

F-FOS-00335 The EOC shall receive TDRSS schedules and User Performance Data (UPD) from the Network Control Center (NCC).

Note: Reference the Interface Control Document between the NCCDS and GSFC MOCs for specifics pertaining to this interface.

F-FOS-00340 The EOC elements shall submit TDRSS schedule requests and Ground Configuration Message Requests to the NCC.

Note: Reference the Interface Control Document between the NCCDS and GSFC MOCs for specifics pertaining to this interface.

F-FOS-00345 The EOC shall receive status data from EDOS.

Note: Reference the Interface Control Document between the EOC and EDOS for specifics pertaining to this interface.

F-FOS-00347 The EOC shall send command data to EDOS for subsequent uplink to the EOS spacecraft.

Note: Reference the Interface Control Document between the EOC and EDOS for specifics pertaining to this interface.

F-FOS-00350 The EOC shall receive from telemetry data EDOS, including real-time and rate-buffered housekeeping and engineering data from EOS instruments and spacecraft.

Note: Reference the Interface Control Document between the EOC and EDOS for specifics pertaining to this interface.

4.5 Security

This section specifies the overall FOS security requirements. In the following requirements, security controlled data are those that have limited access and security protection constraints based on the user authorization level.

F-FOS-00420 The FOS shall require unique sessions for each operator that access the FOS.

F-FOS-00425 The EOC shall maintain an audit trail of:

a. All accesses to the element security controlled data
b. Users/processes/elements requesting access to element security controlled data
c. Data access/manipulation operations performed on security controlled data
d. Date and time of access to security controlled data
e. Unsuccessful access attempt to the element security controlled data by unauthorized users/elements/processes
f. Detected computer system viruses and worms
g. Actions taken to contain or destroy a virus

F-FOS-00430 The FOS shall require a unique user identification and password for each individual user.

F-FOS-00435 The EOC shall report detected security violations to the SMC.

F-FOS-00445 The EOC shall report all detected computer viruses and actions taken to the SMC.

F-FOS-00450 The EOC LAN shall be able to perform filtering based on network address to control access for external and internal interfaces.

Note: The network address filtering allow/disallows access for particular hosts or groups of hosts.

F-FOS-00455 The EOC LAN shall be able to perform filtering based on TCP socket number to control access for external and internal interfaces.

Note: The TCP socket number provides filtering based on network application such as Telnet, FTP, mail, finger, etc.

F-FOS-00460 The EOC LAN shall be able to perform filtering based on protocol to control access for external and internal interfaces.

Note: The protocol allows to filter based on type of protocol, such as TCP/IP, Apple Talk, DECnet.

F-FOS-00465 The IST toolkit shall provide data integrity services for remote IST users communicating with the EOC.

Note: The use of the data integrity services for sending information from the IST to the EOC will be evaluated on a case-by-case basis.

F-FOS-00470 The FOS shall provide the capability to authenticate users without sending passwords in the clear across networks.

F-FOS-00475 The FOS shall provide the capability to limit access of EOC files to authenticated IST users.

F-FOS-00480 The FOS shall provide authentication, authorization, and data integrity services that can be used by ISTs located inside and outside the United States.

F-FOS-00490 The EOC shall provide for security safeguards to cover unscheduled system shutdown (aborts) and subsequent restarts, as well as for scheduled system shutdown and operational startup.

4.6 Operational Availability

Operational availability is defined as the fraction of time an operational capability is ready for use when needed, over the entire life cycle of the equipment. Operational availability for ECS, Ao, is defined as follows:

Ao = \f(MTBM, MTBM + MDT+ST)

MTBM : Mean Time Between Maintenance (defined in the glossary)

MDT: Mean Down Time (defined in the glossary)

ST: Standby Time (or switchover time - defined in the glossary)

F-FOS-00500 FOS functions shall have an operational availability of 0.96 at a minimum (.998 design goal) and an MDT of four (4) hours or less (1.5 hour design goal), unless otherwise specified.

The above requirement covers equipment including:

a. "Non-critical" equipment configured with the critical equipment supporting the functional capabilities in the requirements

b. Equipment providing other functionality not explicitly stated in the RMA requirements that follow.

The RMA requirements in the remainder of this section pertain to equipment required to support the functional capabilities stated in the requirements.

F-FOS-00505 The FOS shall have an operational availability of 0.9998 at a minimum (.99997 design goal) and an MDT of one (1) minute or less (0.5 minute design goal) for critical real-time functions that support:

a. Launch

b. Early orbit checkout

c. Orbit adjustment

d. Anomaly investigation

e. Recovery from safe mode

f. Routine real-time commanding and associated monitoring for spacecraft and instrument health and safety

F-FOS-00510 The EOC shall have no single point of failure for functions associated with real-time operations of the spacecraft and instruments.

F-FOS-00515 The FOS shall have an operational availability of 0.99925 at a minimum (.99997 design goal) and an MDT of five (5) minutes or less (0.5 minute design goal) for non-critical real-time functions.

F-FOS-00520 The FOS shall have an operational availability of 0.992 at a minimum and a MDT of (1) hour or less for functions associated with Targets of Opportunity.

4.7 Evolution of Flight Operations

F-FOS-00605 The FOS shall enable the existence of additional ISTs if required by the PI/TL to accommodate instrument team members, who may be at geographically separate locations.

F-FOS-00610 The EOC architecture shall be capable of growing to support additional spacecraft without major redesign.

F-FOS-00615 The EOC shall be capable of monitoring and commanding up to seven spacecraft and/or simulators simultaneously according to the following allocation:

a. Five (5) operational spacecraft

b. One (1) transition spacecraft

c. One (1) test spacecraft

F-FOS-00620	The FOS shall be capable of growing to support up to 35 IST connected to the EOC network concurrently.
F-FOS-00630	(see NASA Inst. IRD, rqmt #N1-0250): The FOS shall be expandable to support the capability to communicate with the DSN and WOTS to schedule support for EOS spacecraft (in accordance with NASA policy and procedures)

5. Hardware Requirements

This section delineates the specification level requirements for the FOS hardware. The specification level requirements provide enough detail to implement the FOS hardware configuration.

5.1 Real-Time Servers

This section is organized as follows:

5.7 Internal Communication Network

5.7.1 Local Area Network

5.7.2 Network Test Equipment

5.8 Facility Requirements

5.8.1 EOC Equipment

5.1.1 Real-Time Server: Processors

The EOC will provide processors and peripheral equipment necessary for processing spacecraft telemetry and commands as required by the FOS system design. Redundant Real-Time Server Processors will be provided to prevent a single point of failure.

F-HRD-00005 Each Real-Time Server shall be physically and functionally identical in supporting the FOS processing requirements.

F-HRD-00010 The Real-Time Server shall include a dedicated CRT to be used as the local systems operations console.

F-HRD-00015 The Real-Time Server shall be upgradeable/expandable with additional quantities and types of peripherals.

F-HRD-00020 The Real-Time Server shall be upgradeable/replaceable within the same product family without the need for any perturbation of any software or replacement of any peripheral or attached component.

F-HRD-00025 At a minimum, the Real-Time Server processor shall meet the following capacity and functional requirements:

a. POSIX compliant IEEE 1003.1 operating system (UNIX).

b. POSIX compliant IEEE 1003.4 real-time extension

c. Shall support 2 FDDI interface cards.

5.1.2 Real-Time Server Local Disk Drives

The Real-Time Server disk drives will have the capacity to meet Real-Time Server operational requirements for processing telemetry and commands.

F-HRD-00030 Real-Time Server disk drives shall provide a minimum of 4 gigabytes and shall be upgradeable to 8 gigabytes.

F-HRD-00035 All disk drives serving a specific function (e.g. system and applications software, or data storage) shall be identical and will have equal capacity.

5.1.3 Real-Time Server Local Tape Drive

Real-Time Server tape drives will support Real-Time Server data storage and retrieval requirements.

F-HRD-00040 Each Real-Time Server shall support one tape drive.

F-HRD-00045 Each Real-Time Server tape drive shall have the following characteristics:

a. 4mm Digital Audio Tape (DAT) format

b. Accept industry standard magnetic 4mm DAT (i.e. DDS-90)

c. Data transfer rate of 400KB/sec

F-HRD-0050 The Real-Time Server tape drives shall be upgradeable/replaceable within the same product family.

5.1.4 Real-Time Server Local CD-ROM Drive

Real-Time Server CD-ROM drives will support Real-Time Server system software installation and retrieval requirements.

F-HRD-00055 Each Real-Time Server shall support one CD-ROM drive.

F-HRD-00060 Each Real-Time Server CD-ROM drive shall have the following characteristics:

a. Accept 600MB Compact Disk

5.1.5 Real-Time Printers

Shared system printers (5.5) will be available for the operations personnel to print real-time data. These will be directly attached to the network, but be dedicated to real-time operations.

5.1.6 Real-Time Server Hardware Cabinet

The Real-Time Server processor will be housed within a standard 19-inch width electronic equipment cabinet.

F-HRD-00065 The cabinet shall provide a RETMA standard 19 inches of equipment mounting width.

F-HRD-00070 The cabinet shall be a minimum of 54" and a maximum of 72" tall, with standard 19" rack mounts.

F-HRD-00075 The cabinet shall provide a minimum of 24 inches of equipment mounting depth.

F-HRD-00080 The cabinet shall accommodate EIA Universal Standard RS-310 hole spacing or provide for a continuously adjustable equipment and panel mounting system.

F-HRD-00085 The cabinet shall provide removable side panels and rear door.

F-HRD-00090 The cabinet shall provide earth continuity for all components within.

F-HRD-00095 The cabinet shall provide sufficient equipment ventilation.

F-HRD-00100 The cabinet shall supply a minimum of one power controller.

5.2 User Station

5.2.1 User Station Processors

User stations will be provided to support the operation of FOS by spacecraft operators, schedulers, engineers, and analysts.

F-HRD-01005 At a minimum, each processor shall meet the following capacity and functional requirements:

a. POSIX compliant IEEE 1003.1 operating system (UNIX)
b. Support AUI 802.3 ethernet connection.
c. Support 2GB internal disk.

F-HRD-01010 Each User Station shall provide one QWERTY keyboard which shall:

a. Be detachable and cabled for movement on a desk-top style workstation area
b. Provide a minimum of 12 programmable function keys

F-HRD-01015 Each User Station shall provide one color text and graphics display device which shall:

a. Display the complete ASCII character set
b. Provide a minimum of 1024 pixel x 864 lines resolution display
c. Display a minimum of 16 colors
d. Display pages 24 lines by 80 characters wide
e. Display a minimum of four screen display pages
f. Display pages readable from any location along the width of the workstation and up to a distance of 6 feet from the screen
g. Provide a minimum of 19 inches diagonal non-glare screen
h. Provide RGB video output for hard copy
i. Feature an integral swivel/tilt base
j. Provide brightness, contrast and power controls within easy reach.
k. Be physically relocatable within the operations center

F-HRD-01020 The User Station shall provide one cursor pointing device (mouse)

F-HRD-01025 The User Station shall be upgradeable/replaceable within the same product family.

5.2.2 User Station Printers

Shared system printers (5.5) will be available for the operations personnel using the User Stations. These will be directly attached to the network, providing a pool of printers for all User Stations.

5.2.3 Video Hardcopy

The EOC will provide color graphics devices which generate a hardcopy of the User Station visual display. Each User Station will have equal access to the device.

F-HRD-01030 The video hardcopy device shall provide a minimum of 16 colors.

F-HRD-01035 The video hardcopy device shall be physically relocatable within the EOC.

F-HRD-01040 The video hardcopy device shall be capable of printing 2 pages per minute.

F-HRD-01045 The video hardcopy device shall be controlled from a remote control.

5.3 Data Server

5.3.1 Data Server: Processors

EOC Data Servers are responsible for simultaneously controlling all external data interfaces and internally transferring data within the EOC. Redundant Data Servers will be provided to prevent a single point of failure.

F-HRD-02005 The Data Server processors shall be physically and functionally identical in supporting the FOS processing requirements.

F-HRD-02010 Each Data Server shall include a dedicated CRT to be used as the local systems operations console.

F-HRD-02015 Each Data Server shall be upgradeable/expandable with additional quantities and types of peripherals.

F-HRD-02020 Each Data Server shall be upgradeable/replaceable within the same product family without the need for any perturbation of any software or replacement of any peripheral or attached component.

F-HRD-02025 At a minimum, each Data Server processor shall meet the following capacity and functional requirements:

a. POSIX compliant IEEE 1003.1 Operating System (UNIX)

b. Shall support 2 FDDI interface cards.

5.3.2 Data Server Disk Drives

Data Server disk drives will have the capacity to meet Data Server operational requirements.

F-HRD-02030 Data Server disk drives shall provide a minimum of 4 gigabytes and shall be upgradeable to 8 gigabytes.

F-HRD-02035 All drives serving a specific function (e.g. system and applications software, or data storage) shall be identical and will have equal capacity.

5.3.3 Data Server Tape Drives

Data Server tape drives will support Data Server data storage and retrieval requirements.

F-HRD-02040 Each Data Server shall support one tape drive.

F-HRD-02045 Each Data Server tape drive shall have the following characteristics:

a. 4mm Digital Audio Tape format

b. Accept industry standard magnetic 4mm DAT (i.e. DDS-90)

c. Data transfer rate of 400KB/sec

F-HRD-02050 The Data Server tape drives shall be upgradeable/replaceable within the same product family.

5.3.4 Data Server CD-ROM Drives

Real-Time Server CD-ROM drives support Data Server system software installation and retrieval requirements.

F-HRD-02055 Each Real-Time Server shall support one CD-ROM drive.

F-HRD-02060 Each Real-Time Server CD-ROM drive shall have the following characteristics:

a. Accept 600MB Compact Disk

F-HRD-02065 The Real-Time Server CD-ROM drives shall be upgradeable/replaceable within the same product family.

5.3.5 Data Server Hardware Cabinets

The Data Server processor will be housed within a standard 19-inch width electronic equipment cabinet.

F-HRD-02070 The cabinet shall provide a RETMA standard 19 inches of equipment mounting width.

F-HRD-02075 The cabinet shall provide a minimum of 48 vertical Units (1 Unit = 1.75") of equipment mounting height.

F-HRD-02080 The cabinet shall provide a minimum of 24 inches of equipment mounting depth.

F-HRD-02085 The cabinet shall accommodate EIA Universal Standard RS-310 hole spacing or provide for a continuously adjustable equipment and panel mounting system.

F-HRD-02090 The cabinet shall provide removable side panels and rear door.

F-HRD-02095 The cabinet shall provide earth continuity for all components within.

F-HRD-02100 The cabinet shall provide sufficient equipment ventilation.

F-HRD-02105 The cabinet shall supply a minimum of one power controller.

5.4 Data Storage Unit

5.4.1 Network RAID

Data Server Unit: RAID (Redundant Array of Independent Disks) will have the capacity to meet FOS operational requirements.

F-HRD-03005 Shall be compatible with POSIX compliant operating systems.

F-HRD-03010 Shall be accessible from servers and workstations on the network.

F-HRD-03020 All RAID drives shall be identical and have equal capacity.

F-HRD-03025 RAID shall support RAID level-5: striping with interleaved parity.

Note: Disk striping with interleaved parity.

F-HRD-03030 Disks shall be Hot Swappable.

Note: Parts are replaceable while device is powered on.

F-HRD-03035 The following components shall be Hot Swappable: power supplies, fans, disk-array controllers

F-HRD-03040 The RAID unit shall be network attached or hosted to a minimum of 2 front-end processors.

F-HRD-03045 The RAID unit shall have a data transfer rate of 20MB per second.

5.5 System Printers

5.5.1 Laser Printers

The EOC will provide high-speed printers capable of printing FOS events, snaps, dumps and listings.

F-HRD-04005 There shall be a minimum of five system printers located at the EOC.

F-HRD-04010 The system printers shall be physically and functionally identical in supporting the FOS printing requirements.

F-HRD-04015 The printers shall be capable of printing 8 pages per minute.

5.5.2 Logging Printers

The EOC logging printer will be capable of printing delogged history files and reports.

F-HRD-04020 There shall be a minimum of two logging printers located at the EOC.

F-HRD-04025 Each logging printer shall be capable of printing a minimum of 1200 lines per minute.

F-HRD-04030 The printer shall support continuous feed paper.

5.6 Timing Interface

All processors will utilize the same time reference, which will be obtained from a government furnished NASA-36 bit serial time code signal. The FOS will have a network time server and time code display showing GMT for the users.

5.6.1 Time Servers

The time server shall receive NASA-36 time, and provide that time to the real-time servers.

F-HRD-05005 There shall be a minimum of two network time servers located at the EOC.

F-HRD-05010 The time reference for each network time server shall be a GFE NASA-36 bit serial time code signal.

F-HRD-05015 The time server shall support the network time protocol (NTP).

5.6.2 Time Displays

F-HRD-05020 There shall be a minimum of two time code displays located at the EOC.

F-HRD-05025 There shall be at least one up counter, down counter and universal time code display in the EOC.

5.7 Internal Communication Network

5.7.1 Local Area Network

A local area network will be provided to support communications between the Real-Time Servers, Data Servers, and User stations at the EOC.

F-HRD-06005 The local area network shall support 100Mbps bandwidth and 10 Mbps baseband (different segments) as described by the IEEE 802.3 standard, and shall provide:

a. Data Integrity - The network shall check for transmission errors.

b. Redundancy - Redundant connectivity shall prevent a single point of failure.

c. Expandability - The network must be able to support up to 100 connections.

5.7.2 Network Test Equipment

The EOC will provide equipment for monitoring network performance, operation, checkout, and test.

F-HRD-06010 The EOC shall be designed with system test features to enable checkout and test with minimum impact on operations, including test points, "T" connections, break-out boxes, and permanently installed test equipment.

F-HRD-06015 Test equipment to be provided include:

a. One communications line monitor to store and display up to 10,000 bytes of data sent and received over any of the communications lines at rates of 10MB/sec to 100MB/sec, and supporting the protocols used by FOS.

b. One Metallic Cable Time Domain Reflectometer

c. One digital VOM/multimeter

d. One Local Area Network analyzer

5.8 Facility Requirements

5.8.1 EOC Equipment

F-HRD-07005 The EOC shall provide (for AM-1) three (3) Real-Time Servers configured with:

a. Six Fixed Disks (two per Real-Time Server)

b. Three Tape Drives (one per Real-Time Server)

c. Three CD-ROM Drives (one per Real-Time Server)

d. Three Operator Consoles (one per Real-Time Server)

e. Three System Printers (one per Real-Time Server)

f. Three Timing Interfaces (one per Real-Time Server)

F-HRD-07010 The EOC shall provide (36) User Stations, which can perform any EOC subsystem function.

F-HRD-07015 The EOC shall provide three (3) Data Servers configured with:

a. Six Fixed Disks (two per Data Server)

b. Three Tape Drives (one per Data Server)

c. Three CD-ROM Drives (one per Data Server)

d. Three Operator Consoles (one per Data Server)

F-HRD-07017 The EOC shall provide one Data Storage Unit supporting RAID level 5.

F-HRD-07020 The EOC shall provide a redundant Local Area Network.

F-HRD-07025 All EOC workstations and processors shall be capable of operating simultaneously and independently.

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6. Scheduling Requirements

Section 6 contains the requirements associated with the scheduling activity phase. This includes the Planning and Scheduling subsystem and the Command Management subsystem.

6.1 Planning and Scheduling Subsystem

The Planning and Scheduling Subsystem is responsible for producing an integrated and conflict-free schedule of planned operations for the AM-1 spacecraft. A common set of planning and scheduling capabilities will be available to the FOS for supporting instrument and subsystem scheduling.

This section is organized as follows:

Section Title

6.1 Planning and Scheduling
- 6.1.1 Long Term Plans
- 6.1.2 Mission Plans
- 6.1.3 Mission Schedules
  - 6.1.3.1 Building Activities
  - 6.1.3.2 Scheduling Activities
  - 6.1.3.3 Baseline Activity Profiles
  - 6.1.3.4 Resource Profiles
  - 6.1.3.5 Communication Contracts
  - 6.1.3.6 Detailed Activity Schedules
- 6.1.4 Constraints and Modeling
- 6.1.5 Performance Requirements
- 6.1.6 Mission Events
- 6.1.7 Uplink Scheduling
- 6.1.8 Reports

The planning and scheduling process starts with long term planning. Approximately every six months long term plans will be formulated for the spacecraft and each instrument that will span the life of the spacecraft mission. These plans will capture mission priorities and may include significant upcoming events. They will form the basis for the more detailed near term planning that will follow.

Approximately a month in advance, initial scheduling will start. The purpose of this phase of scheduling is to determine the resource needs of the instruments and spacecraft subsystems. The allocation of resources or resource profiles will be based on agreements between the FOT and instrument teams. Under normal circumstances each group will be able to fulfill their needs well within their allotted profiles. In those cases where resource levels are not adequate, the FOT and

instrument teams will be able to make adjustments. Once resource levels are finalized, satellite contacts will be requested and scheduled for satisfying the instrument data volume needs.

Several weeks in advance the FOT and instrument teams will begin final scheduling and will start to define the detailed activities they wish to be performed. As in initial scheduling, they will be notified of any activities that create conflicts or that violate spacecraft and/or instrument constraints. They will also be able to coordinate any activities that involve multiple instruments.

Once conflicts are resolved a detailed activity schedule will be available for the Command Management Subsystem to use for generating spacecraft command loads. If Targets of Opportunity (TOO) or late changes occur, the FOT will be able to insert new activities into the schedule and update the next command load. After the command load is uploaded and executed, the detailed activity schedule will be archived and made available for future analysis.

6.1.1 Long Term Plans

The EOC will provide the capability of viewing the contents of all long term plans. These plans outline information related to science objectives, instrument operations and subsystem operations over a five year duration. The Long Term Science Plan (LTSP) is developed by the Investigator Working Group (IWG) and Project Scientist, defining the primary science objectives of the EOS spacecraft and instruments. Each instrument will have a Long Term Instrument Plan (LTIP) that outlines instrument-specific details on collections, maintenance and calibrations. Similarly, the Long Term Spacecraft Operations Plan will describe anticipated spacecraft subsystem operations and maintenance, along with forecasted orbit maneuvers from the Flight Dynamics Facility. These plans will be used as the basis for more detailed near-term planning.

F-PAS-00010	The EOC shall obtain the Long Term Science Plan (LTSP) from the ECS SMC element. Note: Requirements to store, maintain, and control access to the LTSP appear in the Data Management subsystem section 9.2.2.4.
F-PAS-00015	The EOC shall obtain the Long Term Instrument Plan (LTIP) from the ECS SMC element. Note: Requirements to store, maintain, and control access to the LTSP appear in the Data Management subsystem section 9.2.2.4.
F-PAS-00020	The EOC shall provide the capability for an authorized user to create a long term spacecraft operations plan.
F-PAS-00025	The EOC shall provide the capability for an authorized user to maintain a long term spacecraft operations plan.
F-PAS-00030	The EOC shall provide the capability for an authorized user to update a long term spacecraft operations plan.
F-PAS-00035	The EOC shall provide the capability for an authorized user to view a long term spacecraft operations plan.

6.1.2 Mission Plans

The FOS will provide the capabilities to create and maintain a continuous mission schedule for each spacecraft that includes:

- Resource Profiles
- Activity Schedules
- Detailed Activity Schedules

Once loaded and executing, planners would be able to refer to schedules and correlate them to what is currently executing onboard the spacecraft. In the event real time commands are sent to the satellite, planners would be able to update schedules to make them consistent.

Approximately one week after command execution schedules would be archived. Planners who needed historical data for some sort of analysis would be able to retrieve these back to the start of the mission.

Rather than being separate, these phases will be parts of one continuous timeline. Any activities that are scheduled beyond the normal planning cycle will appear on the long term portion of the timeline. Activities scheduled within the normal planning cycle will migrate as the days pass into the detailed activity portion of the timeline. The Detailed Activity portion of the timeline will contain a subset that will have been released so that a new command load can be generated, a subset that will contain activities for the current generated command load, and a subset that will contain activities for the command load that is currently loaded and executing on the spacecraft. The timeline will contain both future as well as past activities. Planners who need to access past schedules for analysis will be able to scroll into the past on the timeline and retrieve old schedules from the archive.

In order to control the mission schedules the FOT will be able to restrict user privileges for portions of the mission schedule. One way this will be used will be to limit an instrument team to making changes to only those parts of the schedule that pertain to a their instrument. This will prevent updates to other portions of the schedule that affect other instruments. Authorized users may include EOC planners, instrument planners accessing the EOC via the IST toolkit, or IP-ICC planners.

Another way privilege restrictions would be used is when a Detailed Activity Schedule is finalized and released for command load generation. Once a command load is generated the FOT will want to prevent changes from occurring unless they are handled via the late change process. By prohibiting updates to the released portions of the Detailed Activity Schedule the FOT can keep the command load and schedule consistent.

The FDF provides various planning aids to the FOS to support the planning and scheduling process. These include spacecraft predicted orbit data and other mission-specific planning aids which the FOS makes available to spacecraft and instrument planners.

Authorized users will also have the capability to submit changes to mission schedules in a "what-if" mode that will not interfere with existing schedules. This will allow planners to study changes before committing to them and will allow them to evaluate several alternatives without risking the loss of scheduled activities already in place.

This section presents planning and scheduling requirements that apply to the scheduling functions as described above.

F-PAS-00100 The FOS shall provide the capability for an authorized user to view any portion of the mission schedule.

F-PAS-00103 The FOS shall provide the capability for an authorized user to restrict user privileges for updating portions of the mission schedule.

Note: Privileges will include read, write, update, and delete and they can be defined for each spacecraft and instrument resource. They can also be defined for specific time periods.

F-PAS-00105 The FOS shall provide the capability for an authorized user to make updates to a mission schedule for a specific spacecraft.

F-PAS-00110 The FOS shall provide the capability for an authorized user to undo an update to a mission schedule for a specific spacecraft.

F-PAS-00115 The FOS shall provide the capability for an authorized user to create a mission schedule for a specific spacecraft.

F-PAS-00120 The FOS shall provide the capability for an authorized user to delete a mission schedule for a specific spacecraft.

F-PAS-00135 The FOS shall provide the capability for an authorized user to update portions of a mission schedule for a specific spacecraft.

F-PAS-00137 The FOS shall accept predicted orbit data and planning aids for EOS spacecraft from the FDF.

F-PAS-00138 The FOS shall make predicted orbit data and planning aids for a specific spacecraft available to authorized users.

F-PAS-00140 The FOS shall provide the capability to notify the user when he attempts to schedule an activity beyond the limit of the predicted orbit data provided by the FDF.

Note: Any activities requested beyond this limit can be scheduled but will not be associated with any particular spacecraft orbit or ground trace. The FOS will not be propagating orbit data beyond what the FDF provides.

F-PAS-00145 The FOS shall provide the capability for an authorized user to receive updated spacecraft orbit data from the FDF.

F-PAS-00150 The FOS shall provide the capability for an authorized user to incorporate updated orbit data from the FDF into the mission schedule for a specific spacecraft.

F-PAS-00153 The FOS shall notify the user when an activity in a mission schedule is affected by updated orbit data from FDF.

F-PAS-00155 The FOS shall provide FDF orbit data to the ECS SDPS.

F-PAS-00160 The FOS shall provide the capability for an authorized user to make 'what-if' changes without affecting the mission schedule for a specific spacecraft.

Note: 'What-if' changes will allow planners to study alternate mission schedules in an off-line and non-interfering mode. Capabilities like constraint checking that are available for mission schedules will be available in the ‘what-if’ mode.

F-PAS-00165 The FOS shall provide the capability for an authorized user to discard 'what-if' changes without affecting the mission schedule for a specific spacecraft.

F-PAS-00170 The FOS shall provide the capability for an authorized user to save 'what-if' changes to the mission schedule without affecting the mission schedule for a specific spacecraft.

Note: These changes would be set aside and would not be incorporated. This capability would allow a planner to save a set of changes he has not finished so that he could turn off his machine .

F-PAS-00175 The FOS shall provide the capability for an authorized user to retrieve previously saved 'what-if' changes without affecting the mission schedule for a specific spacecraft.

F-PAS-00180 The FOS shall provide the capability for an authorized user to delete previously saved 'what-if' changes without affecting the mission schedule for a specific spacecraft.

F-PAS-00185 The FOS shall provide the capability for an authorized user to incorporate 'what-if' changes to the mission schedule for a specific spacecraft.

F-PAS-00195 The FOS shall prevent a user from inputting 'what-if' requests to any portion of a mission schedule that he does not have update access for.

6.1.3 Mission Schedules

6.1.3.1 Building Activities

An activity corresponds to a spacecraft, instrument, or ground operation and can be expanded into a set of commands. Activity definitions will be predefined in the Project Database. Each activity definition can include command sequences, ground directives, constraint information, information regarding resource utilization requirements, and a list of parameters that may be defined for a particular instance of the activity.

F-PAS-00200 The FOS shall provide the capability for an authorized user to create an activity definition.

Note: Activity definitions will be stored in the Project Database.

F-PAS-00205 The FOS shall provide the capability for an authorized user to modify an activity definition.

F-PAS-00210 The FOS shall provide the capability for an authorized user to delete an activity definition.

F-PAS-00215 The FOS shall provide the capability to associate a command sequence with an activity.

Note: Commands will be identified using mnemonic names from the Project Database. Commands include spacecraft and ground directives. Constraint checking of command sequences will be done by Data Management as part of the Project Database validation process.

F-PAS-00220 The FOS shall provide the capability to define parameters in an activity definition and associate them with individual commands in an activity command sequence.

Note: The user will be able to specify parameter values when the activity is scheduled.

6.1.3.2 Scheduling Activities

An activity may be scheduled by an authorized user and included on the mission schedule for a specific spacecraft at any time in the planning and scheduling cycle. An activity scheduled after the limits of FDF orbit data is called a 'label' activity and it will be part of the long term portion of the plan. If an activity is scheduled in the period for which there is FDF orbit data it will become part of the mission schedule. When the latest portion of the mission schedule is conflict free the FOT will be able to forward it to the Command Management subsystem for command load and ground script generation. This portion of the mission schedule is referred to as the Detailed Activity Schedule.

F-PAS-00300 The FOS shall provide the capability for an authorized user to schedule an activity for a specific date and time

F-PAS-00310 The FOS shall provide the capability for an authorized user to schedule an activity at user defined intervals starting at a specific date and time.

Note: Planners will be able to select the following intervals: every n seconds (1 - 6000); or every n minutes (1 - 1440); or every n hours (1 - 960); or every n days (1 - 365); or every n weeks (1 - 52); or every n months (1 - 60); or every n years (1 - 10); or every orbit.

F-PAS-00315 The FOS shall provide the capability for an authorized user to schedule an activity at a delta time from some mission event.

F-PAS-00330 The FOS shall assign a unique identifier to each individual activity in the mission schedule.

Note: This will allow planners to specifically identify activities. For instance, if a planner found an activity on a textual report and wanted to display it on the timeline, the unique identifier will help him find it more easily on the timeline.

F-PAS-00335 The FOS shall provide the capability for an authorized user to delete an activity from the mission schedule.

F-PAS-00340 The FOS shall provide the capability for an authorized user to search for and find an activity on the mission schedule by: its name; or its identifier; or the time.

F-PAS-00350 The FOS shall provide the capability for an authorized user to schedule a list of activities.

F-PAS-00355 The FOS shall provide the capability for an authorized user to identify activities on the mission schedule that prevent the scheduling of a specific activity.

Note: This will be used to do impact scheduling. Planners may want to force an activity into the mission schedule. They will be able to insert it into the mission schedule and determine the other activities that are in conflict.

F-PAS-00360 The FOS shall provide the capability for an authorized user to delete activities that prevent the scheduling of a specific activity.

Note: If planners determine that the forced activity will take precedence they will be able to delete other activities in conflict.

F-PAS-00365 The FOS shall provide the capability for an authorized user to collect deleted activities in an activity list.

Note: This will allow planners to reschedule deleted activities.

F-PAS-00370 The FOS shall provide the capability for an authorized user to modify past activities.

F-PAS-00375 The FOS shall provide the capability for an authorized user to delete past activities.

F-PAS-00400 The FOS shall provide the capability for an authorized user to supply optional parameters before an activity is scheduled .

F-PAS-00405 The FOS shall supply predefined default parameter values if optional parameters are not supplied before an activity is scheduled .

F-PAS-00410 The FOS shall provide the capability for an authorized user to modify optional parameters for an activity that is already scheduled .

F-PAS-00415 The FOS shall not allow an optional parameter to be defined out of predefined limits for an activity that is scheduled .

F-PAS-00420 The FOS shall provide read-only access to non-modifiable parameters to be modified for an activity that is scheduled .

Note: Parameters of this type will be able to be modified through the controlled process provided by the Data Management Subsystem.

F-PAS-00425 The FOS shall provide the capability for an authorized user to create an association between multiple activities or mission events.

Note: This will allow planners to coordinate observations involving multiple instruments and/or in-situ collection activities.

6.1.3.3 Baseline Activity Profiles

The Baseline Activity Profile (BAP) definition will provide a means to capture recurring activities so that they can be scheduled in a spacecraft plan more easily. For instance, an instrument may repeat the same activity sequence every orbit. The instrument planner would be able to define this

sequence and store it in a BAP definition. When it is time to schedule another set of activities they can use the BAP definition to fill in the additional orbits without having to manually schedule the same activities over and over.

BAPs will usually be based on the Long Term Science Plan (LTSP) or one of the Long Term Instrument Plans (LTIPs).

Occasionally deviations will be necessary. Planners will be able to schedule individual actives or delete activities directly in the spacecraft plan (see section 6.1.2) .

F-PAS-00500 The FOS shall provide the capability for an authorized user to create a list of recurring activities and store them in a Baseline Activity Profile (BAP) definition for an instrument, spacecraft subsystem, or ground system.

F-PAS-00503 The FOS shall provide the capability for an authorized user to maintain a Baseline Activity Profile (BAP) definition.

Note: 'Maintain' implies that a user will be able to edit or modify a BAP definition.

F-PAS-00505 The FOS shall provide the capability for an authorized user to delete a Baseline Activity Profile (BAP) definition.

Note: For instance, if the cycle were an orbit an instrument planner may want to schedule an activity after every satellite sunrise and sunset. Another instrument planner may want to schedule an activity before each lunar eclipse that occurs in a year.

F-PAS-00510 The FOS shall provide the capability for an authorized user to schedule activities between a start and end time based on a Baseline Activity Profiles (BAP).

Note: This will allow planners to use BAPs to schedule activities. Start and end times will be specified so that the BAP is not propagated out to infinity.

6.1.3.4 Resource Profiles

In the initial stages of planning, the various planners will be determining the level of resources they have available to them. For non-complex instruments, planners will determine their resource needs based on activities they generate from their Baseline Activity Profiles (BAP).

For planners working with complex instruments they will schedule resource reservation activities that will serve as place holders for more detailed activities that will be defined later. These summary activities will not correspond to spacecraft command sequences but they will require the use, or the reservation, of spacecraft resources. This will allow planners to predict power consumption, spacecraft contacts, etc.

During schedule development, planners will be allowed to oversubscribe spacecraft resources (e.g., data volume). Before the detailed activity schedule is released for command load generation, activities that are still over utilizing resources will be removed from the mission schedule.

Resource allocations for each mission will be determined by the Investigator Working Group (IWG). since resources will be used over time, and also since their availability may change over time, the allocation will be able to vary over time. Power is an example of a shared resource.

F-PAS-00600 The FOS shall provide the capability for an authorized user to allocate the amount of a shared resources available to specific users.

F-PAS-00605 The FOS shall provide the capability for an authorized user to predict resource usage and availability based on predefined limits.

F-PAS-00610 The FOS shall provide the capability for an authorized user to predict the amount of resources required for a set of activities scheduled from a start to an end time in the mission schedule.

F-PAS-00615 The FOS shall provide the capability for an authorized user to schedule resource reservation activities in a mission schedule.

Note: These pseudo-activities will serve as place holders for more detailed activities that will be scheduled later in the planning cycle.

F-PAS-00620 The FOS shall provide the capability for an authorized user to replace resource reservation activities with detailed activities.

6.1.3.5 Communication Contacts

Communications for EOS spacecraft will be provided by a variety of means and will be scheduled through appropriate facilities. Contacts will be based on data volume profiles for each individual spacecraft and its associated instruments, and of course the line of sight in-view periods between spacecraft and communication stations or satellites.

F-PAS-00700 The FOS shall provide the capability for an authorized user to plan spacecraft communication contacts.

F-PAS-00705 The FOS shall provide the capability for an authorized user to include direct downlink activities on the mission schedule.

6.1.3.6 Detailed Activity Schedules

The Detailed Activity Schedule will contain activities for a target day that are ready to be converted into spacecraft, instrument, and ground commands. In order to get a Detailed Activity Schedule ready planners will have to resolve all conflicts, eliminate any activities that violate hard constraints, and resolve any areas of the mission schedule where resource usage has been over subscribed. Resource reservation activities must also be converted into detailed activities before a Detailed Activity Schedule is ready.

Once this process is complete planners at the EOC will be able to release the next portion of the Detailed Activity Schedule to command management analysts so that they can build spacecraft command loads and associated ground scripts. In the event changes are necessary, planners will be able to re-release affected portions of the mission schedule. For instance, if a command level constraint violation was discovered planners would need to modify or delete the corresponding activity, add it to the mission schedule, and re-release the changes. Likewise, if a Target of Opportunity (TOO) arose, planners would be able to insert new activities into the re-release affected portions of the mission schedule.

F-PAS-00800 The FOS shall provide the capability for an authorized user to define the start and end times for the Detailed Activity Schedule.

F-PAS-00805 The FOS shall identify all disallowed activities that are between the start and end times for the Detailed Activity Schedule.

Note: Disallowed activities include:

activities that are scheduled in windows;

resource reservation request activities that are place holders for detailed activities;

and activities that cause constraint violations.

F-PAS-00810 The FOS shall provide the capability for an authorized user to remove disallowed activities from the Detailed Activity Schedule.

Note: This is intended to give the FOT the ability to avoid mistakes with an automated check.

F-PAS-00815 The FOS shall provide the capability for an authorized user to specify the users who can define a Detailed Activity Schedule.

F-PAS-00820 The FOS shall provide notification when the total allocation of resources exceeds predefined limits .

F-PAS-00825 The FOS shall not allow resource reservation request activities to be on the Detailed Activity Schedule.

F-PAS-00830 The FOS shall provide the capability for an authorized user to re-release a subset of the previously released Detailed Activity Schedule for command generation.

Note: The start and end times for this subset will be within the original start and end times for the previously released DAS. The concept here is that the FOT will add new activities and eliminate any conflicts . Once they have generated a good mission schedule a new DAS will be released .

F-PAS-00835 The FOS shall ensure that activities in the Detailed Activity Schedule are within predefined resource limits .

F-PAS-00840 The FOS shall ensure that no activities cause hard constraint violations in the Detailed Activity Schedule.

6.1.4 Activity Level Constraints and Modeling

Some activities may violate predefined constraints . Some of the constraints may be due to limitations of a specific instrument or spacecraft subsystem. For instance, an instrument may have a maximum slew rate and may not be able to scan two targets in close proximity.

Other constraints may occur between the instruments and/or subsystems. For instance, if the navigation and propulsion subsystems are performing an orbit maneuver the instruments may need to be placed in a safe mode.

The FOS will provide the capability to identify two types of constraints: hard and soft. Hard constraints impact the health and safety of the spacecraft and will not be allowed in the DAS. An example of a hard constraint is the sun entering the FOV of an instrument, causing potential damage. A soft constraint will not affect spacecraft health and safety, but in nominal situations,

should be avoided. An example of a soft constraint is over utilization of an instrument's data volume, potentially causing lost data. Soft constraints will be flagged and only allowed in the DAS, after the proper approval.

F-PAS-00900 The FOS shall provide the capability to identify any activity in the mission schedule that causes a soft constraint violation.

F-PAS-00905 The FOS shall provide the capability to identify any activity in the mission schedule that causes a hard constraint violation.

F-PAS-00910 The FOS shall provide the capability to determine the constraints that an activity is violating.

F-PAS-00915 The FOS shall model the spacecraft power subsystem.

F-PAS-00920 The FOS shall model spacecraft data volume.

F-PAS-00925 The FOS shall be able to determine when the sun is in the field of view limits of an instrument.

F-PAS-00930 The FOS shall be able to model a nominal spacecraft attitude.

F-PAS-00935 The FOS shall be able to model spacecraft attitude offsets.

F-PAS-00940 The FOS shall be able to model state and mode changes in an instrument.

F-PAS-00945 The FOS shall be able to determine when an activity violates an 'order' constraint.

Note: An 'order' constraint is one which states that activities must be scheduled in a certain order.

F-PAS-00950 The FOS shall be able to determine when an activity violates a time spacing constraint.

Note: A time spacing constraint is one which states that two activities must be separated by a minimum time interval.

6.1.5 Performance Requirements

F-PAS-01000 The FOS shall be able to schedule one activity in less than 4 seconds.

F-PAS-01035 The FOS shall be able to release a Detailed Activity Schedule (DAS) containing 1000 activities in less than 10 minutes. The process of releasing a DAS includes:

a. Generate a schedule boundary that defines the DAS

b. Identify activities in the DAS that violate hard and soft constraints

c. Change the protections on activities in the DAS to restrict schedule modifications to TOOs and Late Changes

6.1.6 Mission Events

Events will have names, dates, and times associated with them. For example, spacecraft launch and an orbit's ascending nodal crossing time may be treated as events. In earlier sections there are requirements to provide capabilities to schedule activities at some time before or after an event. If

there will be a critical calibration that must occur six months after spacecraft launch, a planner would be able to use the launch event to schedule this activity.

F-PAS-01120 The FOS shall include the beginning and ending of scheduled activities as mission events.

F-PAS-01125 The FOS shall provide the capability for an authorized user to include orbital events as mission events.

F-PAS-01130 The FOS shall provide the capability for an authorized user to generate (TBR) orbital events that are not provided by the FDF.

Note: This requirement will become more specific as the FDF ICD is established. Examples of FOS generated orbital events may be: sun entering the instrument FOV or target visibility to an instrument FOV.

6.1.7 Uplink Scheduling

The planning and scheduling subsystem acts as the front-end for scheduling the uplink times of spacecraft and instrument loads. For each load, the FOS will provide the capability of scheduling an uplink window that indicates the time period the user would prefer the load to be sent. The time period may correspond to a specific communication's contact (e.g. one TDRSS contact) or a longer time duration (e.g. a 24 hour time period). The planning and scheduling subsystem will use the uplink window for choosing a communication contact upon which the FOT will send the load. If a communication contact cannot be established that satisfies the user request, the user will be notified.

F-PAS-01200 The FOS shall provide the capability for an authorized user to accept a user request specifying an uplink window for a load.

F-PAS-01205 The FOS shall verify the existence of a load specified in the uplink request.

F-PAS-01210 The FOS shall verify a load is valid over the time period specified in the uplink request.

F-PAS-01215 The FOS shall use an uplink window request to schedule the uplink of a load.

6.1.8 Reports

F-PAS-01300 The FOS shall provide the capability for an authorized user to generate a graphical timeline plot of a mission schedule.

F-PAS-01305 The FOS shall provide the capability for an authorized user to generate a text hardcopy of the scheduling constraint event messages.

F-PAS-01310 The FOS shall provide the capability for an authorized user to generate a text hardcopy that summarizes a mission schedule.

Note: This report will be a textual list of activity names, scheduled times, parameters, etc.

6.2 Command Management Subsystem

The Command Management Subsystem (CMS) is responsible for providing tools used to manage the planned operations of the U.S. EOS spacecraft and their instruments. Planned operations are managed by means of ground scripts, preplanned command procedures, and spacecraft and instrument loads containing stored commands, data, or software. Ground scripts are created by CMS based on the DAS created by PAS. Preplanned command procedures are created by the Procedure Builder, described in Section 9.1.2.8, and validated by CMS.

Loads are generated by CMS from load content information. Load contents are built or received by CMS, depending on the load type. For some load types, the load contents are validated by CMS. CMS generates loads from load contents by reformatting the contents and preparing the load for uplink, or by simply preparing the load for uplink, depending on the load type. The five types of load contents used by CMS to generate loads are: absolute time command, which are created by CMS in a mission-specific format; relative time sequence, which are created either by FUI or externally to the FOS and must follow a format defined in the PDB; table, which are created either by FUI or externally to the FOS and must follow a format defined in the PDB; microprocessor, which are created externally to the FOS; and flight software, which are created externally to the FOS.

The CMS also generates reports on load contents and current uplink status and maintains information on the current state of spacecraft memory.

This section is organized as follows:

6.2.7 Ground Script Report

6.2.8 Load Generation Performance

6.2.9 Memory Images

6.2.10 Command Procedure Validation

6.2.1 Absolute Time Command (ATC) Loads

The ATC processor on board the spacecraft controls the execution of absolute time commands in the central spacecraft computer. The ATC processor uses the time tag associated with each absolute time command in its list of absolute time commands to determine when the command should be distributed to the appropriate instrument or spacecraft subsystem. In some cases, an absolute time command may trigger a separate sequence of commands, such as a relative time sequence. The size of the list of absolute time commands and the order in which they are examined by the ATC processor depend on spacecraft design. The EOC will generate ATC loads that conform to the requirements for each EOS spacecraft. This section describes the requirements for ATC loads that are common to all EOS spacecraft.

The EOC will generate ATC loads from the DAS. The DAS is a conflict free schedule of spacecraft and EOC activities. The absolute time commands that make up the ATC load will be generated by expanding each activity in the DAS using activity expansion instructions defined in the activity database. The ATC load will be constrained by the command execution restrictions and ATC processing algorithm for a particular spacecraft. The generation of the ATC load may be initiated automatically upon receipt of the DAS, or may be initiated by user request.

The EOC will maintain an ATC memory map showing the status of every location in the ATC buffer. This map will be used to determine the available locations in the ATC buffer into which an ATC load may be uplinked. The EOC will maintain information on the locations of unexecuted commands from previous loads and unusable locations in the buffer. When building an ATC load, the EOC will map each command in the load to an available location in the ATC buffer. If there are not enough available locations to accommodate the entire ATC load, the load will be partitioned and uplinked as multiple loads.

6.2.1.1 Absolute Time Command Generation

F-CMS-00105 The EOC shall expand spacecraft and instrument activities in the DAS into lists of absolute time commands.

Note: Activities will be expanded using expansion instructions defined in the PDB. For complex instruments, the activity expansion may be complex and involve many instrument and spacecraft commands.

F-CMS-00110 The EOC shall provide the capability to modify the expansion of an activity by applying parameter values supplied as part of an activity request.

Note: Activity expansion instructions in the PDB will include information on the applicability of parameter values.

F-CMS-00115 The EOC shall provide the capability to check the absolute time commands in the ATC load against command-level constraints

Note: Command level constraints will be defined in the PDB.

F-CMS-00118 The EOC shall check the number of commands in the ATC load having the same time tag against the maximum allowable number.

F-CMS-00120 The EOC shall provide notification of command-level constraint violations in ATC load contents.

F-CMS-00125 The EOC shall provide the capability to allow "soft" command-level constraint violations to remain in the ATC load.

Note: The PDB will specify "hard" constraints, which cannot be violated, and "soft" constraints, which can be allowed to remain in the ATC load.

F-CMS-00130 The EOC shall provide the capability to prohibit "hard" command-level constraint violations remaining in the ATC load.

Note: The PDB will specify "hard" constraints, which cannot be violated, and "soft" constraints, which can be allowed to remain in the ATC load.

F-CMS-00140 For each absolute time command generated, the EOC shall provide the capability to verify that the spacecraft memory resources needed by the command will be available on the spacecraft at the time the command executes.

Note: For example, if an absolute time command refers to an RTS (by RTS buffer number), the EOC will verify that, at the time the absolute time command executes, the RTS buffer will contain the expected RTS load (as specified by load name in the activity request that resulted in the generation of the absolute time command).

6.2.1.2 ATC Load Generation

F-CMS-00205 The EOC shall provide the capability to generate an ATC load from a list of absolute time commands that covers the same operational period as the DAS.

Note: The operational period (also called a target day) for a DAS will be specified by the planner/scheduler. The nominal operational period for a DAS is 24 hours. Appropriate boundaries for the load will be determined so that the load will approximately cover the same operational period as the DAS.

F-CMS-00210 The EOC shall convert the command portion of each absolute time command from mnemonic to binary form.

Note: The EOC will convert commands to binary using the conversion instructions in the PDB.

F-CMS-00215 The EOC shall convert the time tag of each absolute time command to the applicable spacecraft compatible format.

Note: The format of the time tags for specific spacecraft is discussed in the mission specific volume.

F-CMS-00220 The EOC shall provide the capability to initiate generation of the ATC load which corresponds to a DAS upon request.

F-CMS-00230 The EOC shall format the ATC load to conform to the ATC processing scheme on board the spacecraft.

Note: The ATC processing scheme for specific spacecraft is described in the mission-specific volume.

F-CMS-00235 In support of a late change that occurs after the ATC load for that period has been uplinked, the EOC shall provide the capability to generate a partial ATC load for the late change.

Note: An ATC partial load is defined as an ATC load that starts after the start of the nominal operational period and ends at the same time as the nominal operational period. ATC partial loads will be initiated by and based on DAS updates received from Planning and Scheduling.

F-CMS-00240 The EOC shall provide the capability to generate and append to the ATC load or partial load all necessary load control commands.

Note: Examples of load control commands may include: load initiate command, select table command, load commit command, and buffer switch command. The number, type, and format of load control commands for specific spacecraft are discussed in the mission-specific volume.

F-CMS-00243 The EOC shall provide the capability to add a sequence of absolute time commands to the end of every ATC or ATC partial load.

Note: The sequence of commands will be defined in the PDB . The function of the sequence would be to put the spacecraft and its instruments into a benign state.

F-CMS-00245 The EOC shall have the capability to generate an ATC load report whenever an ATC or ATC partial load is generated.

Note: All load reports generated will be made available to the IOT through use of the IST (See Section 9.1.2.9.3).

F-CMS-00250 The EOC shall provide the capability to include in the ATC load report:

a. the load name
b. Load type
c. Valid uplink period
d. Uplink date and time
e. Load size in bytes
f. Starting and ending ATC buffer locations
g. Execution times of the first and last commands
h. Number of commands
i. Number of critical commands
j. List of control commands
k. A listing of all absolute time commands in the load, including for each command:

1. the command's memory location
2. execution time
3. command mnemonic
4. submnemonics and their values, if applicable
5. command bit pattern
6. criticality indicator

6.2.1.3 ATC Load Uplink Scheduling

F-CMS-00305 The EOC shall determine an uplink window for each ATC load.

Note: The EOC will schedule the uplink of the load for a real-time contact that falls within the uplink window. Requirements for scheduling of load uplinks and for accepting user modifications of the uplink window are in the Planning & Scheduling section of this document.

6.2.1.4 ATC Load Partitioning

F-CMS-00405 The EOC shall provide the capability to determine a break point (or points) for partitioning an ATC load to meet uplink criteria for the spacecraft.

Note: The ATC load partitioning criteria for specific spacecraft are discussed in the mission-specific volume.

F-CMS-00425 The EOC shall provide the capability to partition an ATC load at a user-requested boundary.

Note: The EOC will notify the user if partitioning a load at a user-specified breakpoint would violate constraints defined in the PDB.

6.2.1.5 ATC Load Management

F-CMS-00510 The EOC shall maintain an ATC command-to-memory map consisting of the contents of each location in the ATC buffer.

F-CMS-00530 The EOC shall update the ATC command-to-memory map when the ATC load has been successfully uplinked.

Note: The real-time Command subsystem provides notification to CMS of successful load uplink.

F-CMS-00550 The FOS shall provide the capability to generate a Memory Map Report listing the memory location (offset in ATC buffer) and contents of each location in the ATC buffer.

6.2.2 Ground Script Generation

Routine, planned, real-time activities in the EOC will be performed by execution of a ground script. The ground script consists of a series of ground schedule directives which perform EOC functions such as real-time commanding, load uplink, command verification, and configuration of the EOC software.

The EOC will generate ground scripts from the DAS. The DAS is a conflict free schedule of spacecraft and EOC activities. The ground schedule directives that make up the ground script will be generated by expanding each activity in the DAS using activity expansion instructions defined in the PDB.

The ground script that is generated from a particular DAS will be executed on the ground concurrently with the execution of stored commands on the spacecraft. Stored commands which are scheduled to execute during the operational period covered by the ground script will be included in the ground script for optional display to the FOT at the time of execution.

F-CMS-00610 The EOC shall expand ground activities in the DAS into lists of time tagged ground directives.

Note: The EOC will expand ground activities using expansion instructions defined in the PDB.

F-CMS-00615 The EOC shall provide the capability to modify the expansion of a ground activity into ground directives by applying parameter values supplied as part of an activity request.

Note: Activity expansion instructions in the PDB will include information on the applicability of parameter values.

F-CMS-00620 The EOC shall provide the capability to check the ground directives in the ground script against ground schedule constraints.

Note: Ground schedule constraints will be defined in the PDB.

F-CMS-00625 The EOC shall provide notification of ground schedule constraint violations.

F-CMS-00630 The EOC shall provide the capability to allow "soft" ground constraint violations to remain in the ground script.

Note: The PDB will specify "hard" constraints, which cannot be violated, and "soft" constraints, which can be allowed to remain in the ground script.

F-CMS-00635 The EOC shall provide the capability to prohibit "hard" ground constraint violations remaining in the ground script.

Note: The PDB will specify "hard" constraints, which cannot be violated, and "soft" constraints, which can be allowed to remain in the ground script.

F-CMS-00640 For each stored command that is scheduled to execute, the EOC shall provide a comment in the ground script which specifies the command and is time tagged with the same time as the stored command.

Note: This comment is included in the ground script for optional display to the FOT at the time of stored command execution, and for optional telemetry verification of the execution of the stored command.

F-CMS-00660 For each request to schedule a load uplink activity, the EOC shall provide the capability to verify that the applicable load is available and ready for uplink.

F-CMS-00670 The EOC shall provide the capability to generate a ground script from a list of ground directives that covers the same operational period as the DAS.

Note: The operational period (also called a target day) for a DAS will be specified by the planner/scheduler. The nominal operational period for a DAS is 24 hours. Appropriate boundaries for the ground script will be determined so that the ground script will approximately cover the same operational period as the DAS.

F-CMS-00675 The EOC shall provide the capability to initiate generation of the ground script which corresponds to a DAS upon request.

6.2.3 Relative Time Sequence (RTS) Loads

Relative time sequences on board the spacecraft provide predefined sets of stored commands which generally can be initiated by absolute time command, real-time command, another RTS, or autonomously on board the spacecraft. Usually, each command in an RTS has an associated time tag that controls when the command will be distributed to the appropriate instrument or spacecraft subsystem. The size and structure of each RTS buffer, the number of RTS buffers, and the constraints on RTS processing depend on spacecraft design. The FOS will generate RTS loads that conform to the requirements for each EOS spacecraft. This section describes the requirements for RTS loads that are common to all EOS spacecraft.

The FOS will provide for the building, validation, generation, and uplink scheduling of RTS loads. Also, the EOC provides tools that may be used in the configuration management of RTS loads.

RTS load content may be built by the FOS, either at the EOC or at an IST, using the RTS Load Builder described in section 9.1.5.2. RTS load content also may be built externally to the FOS, imported via an IST or EOC workstation, and validated by the EOC. In either case, the RTS load content must be in mnemonic form. The EOC will validate the command mnemonics and parameters, and the time tags, if applicable for a particular spacecraft.

The EOC will generate an RTS load from valid pre-built RTS load contents. The generation of RTS loads includes converting commands from mnemonic to binary form, converting the time tags (if applicable), and providing appropriate load formatting.

The EOC will maintain a list of all RTS loads that are in the EOC and ready for uplink. The EOC will also maintain an RTS map specifying the load currently loaded into each RTS buffer and a command-to-memory map specifying the content of each RTS buffer.

Note: Scheduling the uplink of an RTS load will be requested in the EOC by the planner/scheduler. The requirements for scheduling the uplink of loads are in the Planning & Scheduling section of this document.

6.2.3.1 Building RTS Load Contents

F-CMS-00710 The FOS shall provide the capability to specify the content of an RTS load.

Note: RTS load contents will be specified using the RTS load builder described in Section 9.1.5.2.

F-CMS-00720 The FOS shall provide the capability to specify the content of an RTS load based on the contents of a previously defined RTS load.

F-CMS-00725 The FOS shall provide the capability to accept an RTS load content imported from the Science Computing Facility (SCF).

F-CMS-00728 The FOS shall provide the capability to accept an RTS load content imported from the Software Development and Validation Facility (SDVF).

F-CMS-00729 The EOC shall validate the source and destination of RTS load content generated externally to the FOS.

F-CMS-00730 The FOS shall provide the capability to validate RTS contents.

Note: The FOS will validate RTS contents using the definition of the RTS buffer characteristics in the PDB.

F-CMS-00735 The FOS shall provide the capability to validate the mnemonics specified in an RTS load contents.

F-CMS-00740 The FOS shall provide the capability to check the relative time commands in the RTS load content against command-level constraints.

Note: Command-level constraints are defined in the PDB.

F-CMS-00745 The FOS shall provide notification of command-level constraint violations in RTS load contents.

F-CMS-00750 The FOS shall provide the capability to allow "soft" command-level constraint violations to remain in the RTS load.

Note: The PDB will specify "hard" constraints, which cannot be violated, and "soft" constraints, which can be allowed to remain in the RTS load.

F-CMS-00755 The FOS shall provide the capability to prohibit "hard" command-level constraint violations remaining in the RTS load.

Note: The PDB will specify "hard" constraints, which cannot be violated, and "soft" constraints, which can be allowed to remain in the RTS load.

6.2.3.2 RTS Load Generation

F-CMS-00810 The EOC shall provide the capability to generate an RTS load from an RTS load content which has been validated.

F-CMS-00820 The EOC shall provide the capability to convert the command portion of each relative time command from mnemonic to binary form.

Note: The EOC will convert commands to binary using conversion instructions from the PDB.

F-CMS-00830 The EOC shall provide the capability to convert the time tag of each relative time command to a spacecraft compatible format.

Note: The format of the time tags for specific spacecraft is discussed in the mission specific volume.

F-CMS-00840 The EOC shall provide the capability to generate and append to the RTS load all necessary load control commands.

Note: Examples of load control commands may include: load initiate command, select table command, load commit command, and buffer switch command. The number, type, and format of load control commands for specific spacecraft are discussed in the mission-specific volume.

F-CMS-00850 The EOC shall generate an RTS load report whenever an RTS load is generated.

Note: All load reports generated will be made available to the IOT through use of the IST (See Section 9.1.2.9.3).

F-CMS-00860 The EOC shall provide the capability to include in the RTS load report the following items, where applicable:

a. Load name
b. Load type
c. Valid uplink period
d. Uplink date and time
e. Load size in bytes
f. RTS buffer number
g. Starting and ending memory locations in the RTS table
h. Number of commands
i. Number of critical commands
j. A listing of all RTS commands in the load, including for each command in the load:
    1. the command's memory location
    2. offset time, if applicable
    3. command mnemonic
    4. submnemonics and their values, if applicable
    5. command bit pattern
    6. criticality indicator

6.2.3.3 RTS Load Management

F-CMS-00910 The EOC shall maintain a catalog of RTS loads existing in the EOC.

Note: The RTS catalog is a list of RTS loads that are available for uplink. The RTS catalog will be used when the scheduling of an RTS load uplink is requested via Planning & Scheduling.

F-CMS-00915 The EOC shall provide the capability to generate an RTS Catalog Report listing load content name associated with each RTS load available for uplink in the EOC.

F-CMS-00920 The EOC shall provide the capability to include in the RTS Catalog Report the RTS buffer identifier for which the load is valid, the load content source, and the valid load uplink window.

F-CMS-00925 The EOC shall maintain an RTS map specifying the name of the RTS load content that is currently loaded into each RTS buffer.

Note: The RTS map will be used to validate absolute time commands that initiate the execution of an RTS. The name of the load content being requested for execution must match the name of the load content in the map.

F-CMS-00930 The EOC shall provide the capability to generate an RTS Map Report listing the name of the load content that is currently loaded into each RTS buffer.

F-CMS-00935 The EOC shall maintain an RTS command-to-memory map specifying the contents of each location in each RTS buffer.

F-CMS-00940 The EOC shall update the RTS command-to-memory map when the RTS load has been successfully uplinked.

F-CMS-00950 The FOS shall provide the capability to generate a Memory Map Report listing the memory location (offset within an RTS) and contents of each location in an RTS buffer.

6.2.4 Table Loads

Tables on board the spacecraft are predefined areas of spacecraft or instrument memory which have been defined in the FOS table data base. These tables can be updated from the ground by table loads. The size, number, and use of these tables on board the spacecraft depend on the spacecraft design. The EOC will generate table loads that conform to the requirements for each EOS spacecraft. This section describes the requirements for table loads that are common to all EOS spacecraft.

The FOS will provide for the building, generation, configuration management, and uplink scheduling of table loads. Table load content may be built by the FOS, either at the EOC or at an IST, by combining user input with a default table definition resident in the PDB. Table load content also may be built externally to the FOS, imported via the IST or EOC workstation, and validated by the EOC.

For those EOS spacecraft that require them, the EOC will generate flight tables using data received from the Flight Dynamics Facility (FDF). Flight tables will be generated in a format predefined for each spacecraft.

The EOC will maintain a catalog of table loads available in the EOC.

Note: Scheduling the uplink of a table load will be requested in the EOC by the planner/scheduler or, for instrument tables, by the IOT via the IST. The requirements for scheduling the uplink of loads are in the Planning & Scheduling section of this document.

6.2.4.1 Building Table Load Contents

F-CMS-01010 The FOS shall provide the capability to build the content of a table load.

Note: Table load contents will be built by combining user input with a table definition in the PDB. The requirements for the table load builder are in Section 9.1.5.1.

F-CMS-01020 The FOS shall provide the capability to build the content of a table load based on a previously defined table content.

F-CMS-01025 The FOS shall provide the capability to accept a Table load content imported from the Science Computing Facility (SCF).

F-CMS-01028 The FOS shall provide the capability to accept a Table load content imported from the Software Development and Validation Facility (SDVF).

F-CMS-01029 The EOC shall validate the source and destination of table load content generated externally to the FOS.

F-CMS-01030 The FOS shall provide the capability to validate the contents of a table load.

Note: The FOS will validate table load contents using the table definition in the PDB.

6.2.4.2 Table Load Generation

F-CMS-01110 The EOC shall provide the capability to generate a table load from a valid table load content.

F-CMS-01120 The EOC shall provide the capability to convert each field of the table from its table load contents form to its spacecraft usable form.

Note: Each field will be converted in accordance with its definition in the PDB.

F-CMS-01130 The EOC shall generate and append to the table load all necessary load control commands.

Note: Examples of load control commands may include: load initiate command, select table command, load commit command, and buffer switch command. The number, type, and format of load control commands are discussed in the mission-specific volume.

F-CMS-01140 The EOC shall provide the capability to generate table loads from data received from FDF.

Note: The tables to be generated from FDF data are specified in the FDF/ EOC ICD.

F-CMS-01150 The EOC shall generate a table load report whenever a table load is generated.

Note: All load reports generated will be made available to the IOT through use of the IST. (See Section 9.1.2.9.3)

F-CMS-01160 The EOC shall provide the capability to include in the table load report:

a. Load name
b. Load type
c. Valid uplink period
d. Uplink time
e. Load size in bytes

f. Starting and ending memory location

g. Contents of the load in hex, and where applicable in decimal

6.2.4.3 Table Load Management

F-CMS-01210 The EOC shall maintain a catalog of table loads existing in the EOC.

Note: The table catalog is a list of table loads that are ready for uplink. The table catalog will be used when the scheduling of a table load uplink is requested via Planning & Scheduling.

F-CMS-01215 The EOC shall provide the capability to generate a Table Catalog Report listing load content name and valid uplink window associated with each table load available for uplink in the EOC.

F-CMS-01220 The EOC shall maintain a table load map specifying the ownership of each table that is defined in the table data base and the name of the table load content that is currently loaded into it.

F-CMS-01225 The EOC shall provide the capability to generate a Table Map Report listing the name of the load content that is currently loaded into each table.

6.2.5 Instrument Microprocessor Loads

Instrument microprocessor load contents are generated externally to the FOS. The FOS is not responsible for validating microprocessor load content. The FOS will, however, validate the identifying information associated with the load content (including the source, destination, and size of the load). Instrument microprocessor loads will be generated in the EOC from the load contents provided.

Note: Not all loads that are sent to instrument microprocessors are considered microprocessor loads by the CMS. RTS loads (see Section 6.2.3) that are sent to instrument microprocessors are treated as RTS loads by the CMS. Table loads (see Section 6.2.4) that are sent to instrument microprocessors are treated as table loads by the CMS.

Note: Scheduling the uplink of a microprocessor load will be requested in the EOC by the planner/ scheduler or by the IOT via the IST. The requirements for scheduling the uplink of loads are in the Planning & Scheduling section of this document.

F-CMS-01305 The FOS shall provide the capability to accept a microprocessor load content imported from the Science Computing Facility (SCF).

F-CMS-01310 The EOC shall validate the source, destination, and size of binary format instrument microprocessor load content generated externally to the FOS.

Note: The valid source, destination, and size of each type of microprocessor load will be specified by the instrument teams. Load size validation will only be at a high level, to ensure the load is not larger than the microprocessor buffer.

F-CMS-01320 The EOC shall generate a microprocessor load from a microprocessor load content.

Note: The requirements for microprocessor loads for specific spacecraft are discussed in the mission specific volume.

F-CMS-01325 The EOC shall generate and append to the microprocessor load all necessary load control commands.

Note: Examples of load control commands may include: load initiate command, select table command, load commit command and buffer switch command. The number, type and format of load control commands are discussed in the mission-specific volume.

Note: The load initiate command includes the CRC. The algorithm for the CRC is provided by the microprocessor instrument teams.

F-CMS-01330 The EOC shall generate a microprocessor load report whenever a microprocessor load is generated.

Note: All load reports generated will be made available to the IOT through use of the IST. (See Section 9.1.2.9.3)

F-CMS-01340 The EOC shall include in the microprocessor load report:

a. Load name
b. Load type
c. Valid uplink period
d. Uplink time
e. Load size in bytes
f. Starting and ending memory location
g. Contents of the load in hex.

F-CMS-01350 The EOC shall maintain a catalog of microprocessor loads available in the EOC.

Note: The microprocessor catalog is a list of microprocessor loads that are ready for uplink. The microprocessor catalog will be used when the scheduling of a microprocessor load uplink is requested via Planning & Scheduling.

F-CMS-01360 The EOC shall provide the capability to generate a Microprocessor Catalog Report listing load content name and valid uplink window associated with each microprocessor load available for uplink in the EOC.

6.2.6 Flight Software Loads

The flight software controls the spacecraft subsystems. Flight software load contents are generated externally to the FOS. The FOS is not responsible for validating flight software load content. The FOS will, however, validate the identifying information associated with the load content (including the source and destination of the load).

F-CMS-01405 The FOS shall provide the capability to accept a flight software load content imported from the Software Development and Validation Facility (SDVF).

F-CMS-01410 The EOC shall validate the source and destination of binary format flight software load content generated externally to the FOS.

F-CMS-01420 The EOC shall generate a flight software load from a flight software load content.

Note: The requirements for flight software loads for specific spacecraft are discussed in the mission specific volume.

F-CMS-01425 The EOC shall generate and append to the flight software load all necessary load control commands.

Note: Examples of load control commands may include: load initiate command, select table command, load commit command, and buffer switch command. The number, type, and format of load control commands are discussed in the mission-specific volume.

F-CMS-01430 The EOC shall generate a flight software load report whenever a flight software load is generated.

Note: All load reports generated will be made available to the IOT through use of the IST. (See Section 9.1.2.9.3)

F-CMS-01440 The EOC shall include in the flight software load report:

a. Load name
b. Load type
c. Valid uplink period
d. Uplink time
e. Load size in bytes
f. Starting and ending memory location
g. Contents of the load in hex.

F-CMS-001450 The EOC shall maintain a catalog of flight software loads available in the EOC.

Note: The flight software catalog is a list of flight software loads that are available for uplink. The flight software catalog will be used when the scheduling of a flight software load uplink is requested via Planning & Scheduling.

F-CMS-01460 The EOC shall provide the capability to generate a Flight Software Catalog Report listing load content name and valid uplink window associated with each flight software load available for uplink in the EOC.

6.2.7 Integrated Report

For each DAS processed, the EOC will produce a report which integrates the load and ground script information related to the period. The report will contain a chronological list of information related to orbital events, command executions, and real-time contacts that are expected to occur during the period. The report will be made available for display at an IST or EOC workstation.

F-CMS-01505 The EOC shall provide the capability to produce an integrated report which includes the following information in chronological order:

a. Absolute time commands to be executed
b. Relative time commands to be executed
c. Scheduled spacecraft contacts
d. Real-time commands to be uplinked
e. Loads to be uplinked
f. Expected orbital events

Note: The Integrated Report will be made available to the IOT via the IST.

F-CMS-01512 The FOS shall be able to produce the planned state of the spacecraft for telemetry parameters that are used in command verification and the location of the stored command pointer upon request.

Note: The set of telemetry parameters that pertain to this requirement are limited to those telemetry parameters used to perform telemetry verification as defined in the Command Project Data Base.

6.2.8 Load Generation Performance

The EOC will have the ability to perform timely load generation and validation.

F-CMS-01610 The EOC shall process all loads associated with a DAS in less than 1 hour. The processing of loads associated with a DAS shall include:

a. Generating an ATC load based on the expanded DAS activities
b. Verifying the current contents of RTS buffers referenced by the ATC load.
c. Generating a ground script based on the expanded DAS activities
d. Verifying the existence in the EOC table load catalog of the table loads that have uplink references in the DAS
e. Verifying the existence in the EOC flight software load catalog of the flight software loads that have uplink references in the DAS
f. Verifying the existence in the EOC microprocessor load catalog of the microprocessor loads that have uplink references in the DAS
g. Verifying the existence in the EOC RTS load catalog of the RTS loads that have uplink references in the DAS

F-CMS-01630 In support of a late change, the EOC shall process all loads associated with the change in less than 1 hour after receiving the updated DAS. The processing of loads associated with the change shall include:

a. Generating an ATC load or ATC partial load based on the expanded DAS activities
b. Verifying the current contents of RTS buffers referenced by the ATC load

c. Generating a ground script based on the expanded DAS activities

d. Verifying the existence in the EOC table load catalog of the table loads that have uplink references in the DAS

e. Verifying the existence in the EOC flight software load catalog of the flight software loads that have uplink references in the DAS

f. Verifying the existence in the EOC microprocessor load catalog of the microprocessor loads that have uplink references in the DAS

g. Verifying the existence in the EOC RTS load catalog of the RTS loads that have uplink references in the DAS

6.2.9 Memory Images

The EOC will maintain memory images of loads. The EOC will maintain a ground reference image containing the expected contents of spacecraft memory. This image will be used to verify the contents of spacecraft memory, to generate reports, and to generate loads. The format of the image and the areas of spacecraft memory to be included depend on spacecraft design. This section describes the requirements for the ground reference image that are common to all EOS spacecraft.

F-CMS-01710 The EOC shall maintain a ground reference image of spacecraft memory.

F-CMS-01715 The EOC shall update the ground reference image by overwriting the appropriate portion of the ground reference image with a load image when the load has been successfully uplinked.

F-CMS-01720 The EOC shall provide the capability to create a memory dump image from collected dump telemetry data.

F-CMS-01725 The FOS shall provide the capability to export instrument memory dump images to the SCF.

Note: Memory dump images will be exported via the IST.

F-CMS-01730 The FOS shall provide the capability to export memory dump images to the SDVF.

F-CMS-01735 The EOC shall provide the capability to overlay a portion of the ground reference image with a memory dump image or load image at user request.

F-CMS-01740 The FOS shall provide the capability to compare a memory image to another memory image.

Note: This capability will ordinarily be used to compare a memory dump image to the ground reference image. It may also be used to compare a dump image to a load image or another dump image, or to compare a load image to another load image.

F-CMS-01743 The EOC shall provide the capability to use a mask to exclude certain areas of memory from comparison.

F-CMS-01745 The EOC shall notify the user via an event message of the status of the memory dump comparison.

F-CMS-01750 The EOC shall provide the capability to generate a report listing all discrepancies found during a memory dump comparison.

F-CMS-01760 The EOC shall provide the capability to generate a Memory Image Report listing the memory location (address) and contents of a user specified area of spacecraft memory.

Note: A Memory Image Report can be based on a ground reference image, a load image, or a dump image.

F-CMS-01765 The EOC shall provide the capability to generate a report of table contents based on a dump image of a table.

Note: The table must be defined in the PDB.

F-CMS-01770 The EOC shall provide the capability to compare contents of a table dump image to predefined default values for the table.

Note: The table and default values must be defined in the PDB.

F-CMS-01775 The EOC shall provide the capability to generate a table load content based on a dump image of a table.

Note: The table must be defined in the PDB.

6.2.10 Command Procedure Validation

The FOS will validate real-time commands contained in preplanned command procedures. This will ensure that command procedures are ready for execution when needed.

F-CMS-01820 The FOS shall validate each field of each real-time command in a procedure.

Note: Each field will be validated in accordance with command PDB definitions.

F-CMS-01825 The FOS shall provide the capability to check the real-time commands in a procedure against command-level constraints.

Note: Command-level constraints are defined in the PDB.

F-CMS-01830 The FOS shall provide notification of command-level constraint violations in command procedures.

F-CMS-01835 The FOS shall provide the capability to allow "soft" command-level constraint violations to remain in a command procedure.

Note: The PDB will specify "hard" constraints, which cannot be violated, and "soft" constraints, which can be allowed to remain in a command procedure.

F-CMS-01840 The FOS shall provide the capability to prohibit "hard" command-level constraint violations remaining in a command procedure.

Note: The PDB will specify "hard" constraints, which cannot be violated, and "soft" constraints, which can be allowed to remain in a command procedure.

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7. Real-Time Operations

Section 7 contains the requirements associated with the Real-Time Operations activity phase. This includes the Resource Management, Telemetry and Command subsystems

7.1 Resource Management Subsystem

The Resource Management Subsystem (RMS), provides the capability to manage and monitor the configuration of the EOC. This includes configuring the EOC resources for multi-mission support and facilitating operational failure recovery during real-time contacts. The Real-Time Contact Management Subsystem (RCM), provides the capability to manage the real-time interfaces with the NCC and EDOS.

The Resource Management Subsystem and Real-Time Contact Management Subsystems are responsible for controlling and coordinating the necessary resources for telemetry monitoring and spacecraft commanding. RMS enables EOC users to receive and monitor telemetry from one or more spacecraft and one or more instruments.

The Resource Management Subsystem receives requests from users for command authority. The EOC allows users to request the privilege to send commands to an EOS spacecraft. The Resource Management Subsystem grants this privilege to authenticated users, and ensures that only one person has command authority for a single spacecraft at any one time.

This section is organized as follows:

7.1.1 Resource Allocation

The Resource Allocation function provides the EOC user the capability to perform real-time telemetry and command processing, spacecraft simulation, and replay of historical telemetry, through the use of logical strings.

Logical strings provide the user access to the collection of hardware and software components necessary for performance of the desired activity. Through the use of multiple logical strings, the user can monitor the desired activity on several spacecraft concurrently. For example, an operator could utilize several logical strings in order to monitor multiple instruments, or the same instrument on multiple spacecraft.

F-RMS-00010 The EOC shall support concurrent real-time operations for up to seven (7) spacecraft and their instruments.

F-RMS-00020 The EOC shall be capable of accepting default ground system information at system startup.

Note: Default ground system information will include default logical strings to be created at system initialization time.

F-RMS-00030 The EOC shall be capable of accepting EOC operator requests to configure the EOC.

Note: Configure refers to the allocation of EOC hardware and software components for a specific use within a logical string.

F-RMS-00035 The EOC shall allow EOC operators to specify a version of the project data base to use in processing data.

Note: For real-time data, the default will be the current project data base, and for historical data the default will be the project data base from the corresponding timeframe.

F-RMS-00040 The EOC shall allow EOC operators to identify EOC resources for operational mode.

Note: Identifying a logical string for operation, test or training mode will not constrain the use of that logical string. This identification merely serves notice to all potential users of the intended use for a given string.

F-RMS-00050 The EOC shall allow EOC operators to identify EOC resources for test mode.

Note: See note for F-RMS-00040.

F-RMS-00060 The EOC shall allow EOC operators to identify EOC resources for training mode.

Note: See note for F-RMS-00040

F-RMS-00070 The EOC shall provide an EOC operator access to real-time data.

F-RMS-00080 The EOC shall provide an EOC operator access to replay data.

Note: Replay data consists of both real-time and spacecraft recorder data currently archived in the ECS.

F-RMS-00090 The EOC shall provide an EOC operator access to simulated data.

F-RMS-00100 The EOC shall provide multiple EOC operators access to the same data stream.

Note: A data stream is defined as a real-time, replay or simulated telemetry stream.

F-RMS-00110 The EOC shall provide a single EOC operator access to multiple data streams.

Note: The number of streams a single operator is allowed to access at one time will not be restricted by the RMS software.

F-RMS-00130 The EOC shall provide an IST operator access to real-time data.

Note: The EOC will not guarantee the receipt of the data in or near real-time, nor will the EOC guarantee the receipt of real-time data packets in order.

F-RMS-00140 The EOC shall provide an IST operator access to replay data.

F-RMS-00150 The EOC shall provide an IST operator access to simulated data.

F-RMS-00160 The EOC shall provide multiple IST operators access to the same data streams.

F-RMS-00170 The EOC shall provide a single IST operator access to multiple data streams.

Note: The number of streams a single IST operator is allowed to access at one time will not be restricted by the RMS software.

7.1.2 User Authorization

The User Authorization function ensures that only one EOC user has the ability to command an EOS spacecraft at any one time. The command privilege is requested by users who wish to send commands to an EOS spacecraft. Once the request is received, the User Authorization software determines if the requesting user is an authorized user before the privilege is granted.

The User Authorization function utilizes a similar process to validate requests from users for the privilege to modify the ground system configuration. With this privilege, authorized users can modify setup on specific pieces of ground equipment.

FOS user authorization and authentication will be performed prior to an EOC or IST user being able to access the system. FOS user authorization and authentication will be provided via the CSMS MSS Subsystem. The MSS Subsystem is described in detail in the Communications and System Management (CSMS) Internal Interface Control Document for the ECS Project (313-CD-003-001)

F-RMS-01010 The EOC shall provide the capability to authorize an EOC operator to command an EOC spacecraft.

F-RMS-01020 The EOC shall ensure a single point of command for a given spacecraft.

F-RMS-01030 The EOC shall accept, validate, and process EOC operator requests to acquire the spacecraft command privilege.

F-RMS-01040 The EOC shall provide the capability to authorize an IP ICC operator to command an IP instrument.

Note: No spacecraft or other instrument commands can be sent while an IP ICC operator is commanding an IP instrument.

F-RMS-01050 The EOC shall accept, validate, and process IP ICC operator requests to acquire the spacecraft command privilege.

F-RMS-01060 The EOC shall provide the capability to authorize an EOC operator to modify the ground system configuration.

F-RMS-01070 The EOC shall allow only one authorized EOC operator, at any given time, the privilege to modify the ground system configuration.

Note: Ground configuration authority is granted on a per logical string basis.

7.1.3 Failure Recovery

The Failure Recovery function provides the capability to reconfigure the system setup to work around faults and anomalies with minimal interruption to mission critical operations. When the Resource Management Subsystem detects an EOC component failure, the Failure Recovery software will provide the EOC operator with the capability to reconfigure the EOC to re-establish the logical strings in the network to continue telemetry and command processing. Failure recovery is an automated process by which the user initiates the transfer of spacecraft control from one logical string to another. Once the transfer process is complete, the user can request command authority for the spacecraft in order to resume spacecraft commanding from the point at which the failure occurred.

F-RMS-02010 The EOC shall process an EOC operator request to initiate the transfer of spacecraft control from one set of hardware and software components to another in order to work around a fault or anomaly.

F-RMS-02020 The EOC shall correct a failure condition with a redundant component within one minute of operator request.

Note: The RMS design goal is to restore normal operations within 30 seconds.

7.1.4 Monitor EOC Status

The Monitor EOC Status function maintains status information on EOC components and notifies users of changes in EOC global variables. The Monitor EOC Status function monitors hardware components, and software components at a fixed time interval. When a change in ground configuration and status is detected, the user is notified.

The Monitor EOC Status function provides current displayable global data for display on both User Stations and Instrument Support Terminals. Each active -- i.e., logically connected, User Station or IST will be provided with current values for a predetermined set of ground configuration parameters. Changes to ground configuration values will be distributed to the User Stations and ISTs on a three second interval.

Note: A list of EOC hardware components monitored, can be included pending publication of a system hardware list.

Note: Unless otherwise specified, components are hardware and software.

Note: The MSS is the CSMS Management Subsystem and is described in further detail in the Communications and System Management (CSMS) Internal Interface Control Document for the ECS Project (313-CD-003-001).

F-RMS-03010 The EOC shall monitor EOC hardware components for changes in status.

Note: The status monitored tells the EOC that the component is active or inactive. The monitor function will be provided by MSS tools that will be employed by the FOS software. Statuses will be reported to the DMS subsystem in the form of management events.

F-RMS-03030 The EOC shall monitor software components for change in status.

Note: The status of the software tasks monitored could be active, inactive, or suspended._The monitor function will be provided by MSS tools that will be employed by the FOS software. Statuses will be reported to the DMS subsystem in the form of management events.

F-RMS-03040 The EOC shall maintain changes to the ground configuration and hardware and software component statuses.

F-RMS-03050 The EOC shall make ground configuration and component statuses available for display to the EOC operators.

F-RMS-03060 The EOC shall make ground configuration and component statuses available for display to the IST operators.

F-RMS-03070 The EOC shall notify the operator of changes in the ground configuration and component statuses.

F-RMS-03080 The EOC shall log changes in the ground configuration and component statuses.

F-RMS-03090 The EOC shall provide the MSS with changes in EOC component statuses.

F-RMS-03240 The EOC shall make performance monitoring and fault management information obtained from the MSS available to the EOC operator.

7.1.5 Interface with NCC

The Interface with NCC provides the capability to exchange messages with the NCCDS via the NASCOM interface. This interface will include the capability to exchange all types of real-time NCC messages. The formats of the messages exchanged are described in detail in the Interface Requirements Document Between Network Control Center Data System and GSFC MOCs.

Note: User Performance Data messages from the NCC will be routed through the Telemetry Sub-system, see Telemetry Requirement 7.2.12.

F-RMS-04010 The EOC shall provide the capability to send User Performance Data Request messages to the NCC.

F-RMS-04020 The EOC shall provide the capability to send the following Ground Configuration Message Requests to the NCC:

a. User Reacquisition Request
b. User Reconfiguration Request
c. Forward Link Sweep Request
d. Forward Link EIRP Reconfiguration Request
e. Expand User Frequency Uncertainty Request
f. Doppler Compensation Inhibit/Enable Request

F-RMS-04080 The EOC shall provide the capability to receive and process Return Channel Time Delay Measurement messages from the NCC.

Note: Reference Section 7.2.5.4.

F-RMS-04085	The EOC shall provide the capability to receive and process Time Transfer messages from the NCC. Note: Reference Section 7.2.5.3
F-RMS-04090	The EOC shall provide the capability to receive and process Acquisition Failure Notification messages from the NCC.
F-RMS-04100	The EOC shall provide the capability to receive and process GCM Status messages from the NCC.
F-RMS-04110	The EOC shall provide the capability to receive and process GCM Disposition messages from the NCC.
F-RMS-04120	The EOC shall provide the capability to exchange Communication Test and Acknowledgment messages to determine prepass operational readiness.

7.2 Telemetry Subsystem

The EOC will provide the capability to receive, process, and monitor telemetry data from the EOS spacecraft. The Real-time Telemetry subsystem will accept EDOS Data Units (EDU) from EDOS or other specified source, extract the CCSDS standard packets from the EDUs, and process those packets whose application identifiers are specified in the Project Data Base. All telemetry processing capabilities described in this section are performed during real-time processing, unless stated otherwise.

This section delineates the specification level requirements for the FOS telemetry subsystem. Related specification requirements are grouped together and described using specification narratives.

The telemetry requirements are organized as follows:

7.2.1 Telemetry Delivery

The EOC will be able to receive and process telemetry from the EOS spacecraft, spacecraft simulators, and EOC accessible telemetry archives. Telemetry data will be delivered to the EOC within EDOS Data Units (EDUs).

7.2.1.1 Accept Telemetry Data

The EOC will accept EOS spacecraft and instrument telemetry from multiple telemetry sources.

F-TLM-00110 The EOC shall be capable of receiving EOS spacecraft and instrument telemetry.

Note: The spacecraft data may originate at the spacecraft contractor facility, spacecraft launch facility, or EDOS.

F-TLM-00115 The EOC shall be capable of receiving EOS spacecraft simulator telemetry.

Note: The spacecraft simulator data may originate at the spacecraft contractor facility, spacecraft software development facility, or EOC.

F-TLM-00120 The EOC shall be capable of receiving historical EOS spacecraft and instrument telemetry.

Note: Historical telemetry data is nominally stored in the EOC short term archive for seven (7) days. Data older that seven (7) days can be retrieved from the GSFC DAAC.

F-TLM-00135 The EOC shall be capable of receiving telemetry in either EDU or CCSDS packet format.

Note: The EOC is required to directly accept and process archived instrument engineering telemetry in CCSDS packet form. Spacecraft and instrument housekeeping telemetry CCSDS packets will be received encapsulated within EDUs.

7.2.1.2 Process EDOS Data Units

The EOC will extract CCSDS standard source telemetry data packets, EDOS ground receipt time, and EDOS accounting information from EDOS Data Units (EDUs) and distribute them for processing. (reference EDOS Functional and Performance Requirements 560-EDOS 0202.0001, EDOS Operations Concept 560-EDOS 0106.0002)

F-TLM-00210 The EOC shall accept EDOS Data Units (EDUs) containing spacecraft and instrument telemetry data.

F-TLM-00215 The EOC shall extract the EDU Service Header (ESH) containing data quality, accounting, and EDOS ground receipt date and time information from the EDU.

F-TLM-00220 The EOC shall extract the Service Data Unit (SDU) containing a CCSDS Version-1 spacecraft or instrument telemetry packet from the EDU.

7.2.2 Telemetry Packet Processing

The FOS will process CCSDS Version-1 telemetry packets that have been extracted from EDUs as Service Data Units. The FOS packet processing includes determining the proper sequence of the received packets and extracting the packet data fields required for further telemetry decommutation.

7.2.2.1 Determine Telemetry Packet Quality

Each EDOS Data Unit (EDU) contains error information within its header that is used for computing the quality of the telemetered CCSDS packet.

F-TLM-00310 The FOS shall base the quality of a packet on the quality indicator received in the EDU header.

Note: EDOS discards packets containing errors which are not correctable via the Reed-Solomon error detection and correction algorithm. The FOS will process all packets which are received.

F-TLM-00315 The FOS shall mark all parameters decommutated from a packet containing an error as having questionable quality.

Note: The FOS performs derived parameter calculations and marks the result as having questionable quality if a data point with questionable quality is required for use in calculating the derived parameter.

7.2.2.2 Process CCSDS Telemetry Packets

The FOS will process Advanced Orbiting System (AOS) CCSDS packets that contain housekeeping, health and safety, memory dump (diagnostic), spacecraft recorder, and instrument engineering data. The packets will be identified via the application process identifier (APID) within each packet primary header. The expected packet length for each APID will be predefined. If the received telemetry packet APID and packet length are not of predefined values, the packet will not be decommutated. The FOS provides additional accounting, such as reporting missing data.

F-TLM-00410 The FOS shall accept a CCSDS Version-1 format telemetry packet of a predefined type and length.

Note: The packets to be processed are defined within the Project Data Base and are organized by APID.

F-TLM-00440 The FOS shall extract from the telemetry packet primary header field the following:

a. The 11-bit packet APID.

b. The 14-bit packet sequence count.

c. The two (2) octet packet length count.

Note: The FOS will examine the CCSDS packet sequence count located within the primary header to determine a proper packet sequence and to detect missing packets.

F-TLM-00445 The FOS shall generate a notification message whenever a missing packet is detected.

Note: Each missing packet notification message will contain the detection time (UTC) and the total number of packets recognized as being missed.

F-TLM-00450 The FOS shall be capable of extracting from the telemetry packet application data field the following:

a. An optional CCSDS packet secondary header field .

b. The packet application process telemetry information.

Note: CCSDS defines the packet secondary header as being an optional data field within each CCSDS packet. However, it is envisioned that this field will be used throughout the EOS missions and will contain an eight (8) octet packet time stamp. The application process telemetry information contains the telemetered spacecraft and instrument sample point values.

F-TLM-00490 The FOS shall provide the capability to convert the packet time stamp according to a specified spacecraft time code conversion algorithm.

Note: Examples of time codes are CCSDS Unsegmented Time Code and CCSDS Day Segmented Time Code. AM-1 uses CCSDS Day Segmented Time Code and does not require spacecraft time fly wheeling. Spacecraft time flywheel is not required for AM-1, but may be necessary for future missions. (Reference "Time Code Formats", Blue Book, CCSDS 301.0-B-2.)

7.2.2.3 Decommutate Telemetry

The FOS provides the capability to accept and decommutate EOS spacecraft and instrument housekeeping or engineering telemetry based on established, predefined telemetry format information.

F-TLM-00510 The FOS shall support the decommutation of spacecraft housekeeping telemetry for the EOS spacecraft.

F-TLM-00515 The FOS shall support the decommutation of instrument housekeeping telemetry for the EOS instruments.

F-TLM-00520 The FOS shall support the decommutation of instrument engineering telemetry for the EOS instruments.

F-TLM-00525 The FOS shall determine the decommutation algorithm for a telemetered CCSDS packet application data field based upon the packet application process identifier (APID).

Note: The FOS supports the processing of engineering data for engineering telemetry downlinked with its own CCSDS packet application identifier.

F-TLM-00530 The FOS shall decommutate telemetry based upon predefined spacecraft and instrument specific decommutation information.

Note: The decommutation information will consist of data necessary for the retrieval and storage of downlinked spacecraft telemetry parameters. This decommutation information will be based on the Project Data Base.

F-TLM-00535 The FOS shall be capable of continuously decommutating real-time spacecraft housekeeping telemetry at rates up to 50 Kbps per spacecraft.

F-TLM-00540 The FOS shall be capable of continuously decommutating real-time instrument housekeeping telemetry at rates up to 50 Kbps per spacecraft.

F-TLM-00545 The FOS shall be capable of continuously decommutating real-time instrument engineering telemetry at rates up to 50 Kbps per spacecraft.

7.2.3 Telemetry Parameter Processing

The FOS will provide spacecraft and instrument telemetry sample point (parameter) extraction and monitoring. Available capabilities include collecting data bits corresponding to samples, checking if sample values are within specified ranges, converting raw sample values to engineering units by application of specified algorithms, and determining whether sample values are changing.

7.2.3.1 Mark Static Telemetry

FOS telemetry decommutation marks individual telemetry parameters as "static" when no recent input telemetry has been decommutated for them.

F-TLM-00610 The FOS shall initially mark all defined telemetry parameters as being static and as having no data available.

Note: A static indicator is associated with each parameter and is accessible for display or other processing.

F-TLM-00620 The FOS shall mark all parameters as static upon data dropout (i.e., no telemetry has been received for 5 seconds).

Note: The default dropout detection period will be data base defined.

F-TLM-00625 The FOS shall mark a parameter static if the given parameter has not been updated for more than a spacecraft major frame.

Note: For example, the AM-1 major frame (master cycle) is repeated approximately every 64 seconds. The FOS will discontinue further parameter processing (e.g., limit checking) when the parameter has been marked static. (reference Section 7.2.3.4 for derived parameter processing)

F-TLM-00635 The FOS shall mark a parameter as being active when it has been successfully decommutated.

7.2.3.2 Decommutate Telemetry Parameters

FOS decommutation provides for the assembly of raw spacecraft and instrument data from multiple contiguous as well as non-contiguous telemetry bits and words.

F-TLM-00710 The FOS shall provide for the assembly of parameters from multiple and contiguous bits.

F-TLM-00715 The FOS shall provide for the assembly of parameters from multiple and non-contiguous bits.

Note: The parameter construction information will be based on the Project Data Base and will include the location of data in the downlink telemetry (packet), the parameter start bit, and the number of bits to gather. This and the previous requirement allow for the decommutation of parameters that cross word boundaries.

F-TLM-00720 The FOS shall be capable of extracting a maximum of 8 "components" for any one telemetry parameter.

Note: Each component is considered a contiguous grouping of bits that are capable of being extracted simultaneously. For each parameter, FOS will have the ability to extract and assemble from one (1) to eight (8) groups of bits whose total number of bits does not exceed thirty-two (32).

F-TLM-00725 The FOS shall provide a mechanism to collect all components before any subsequent processing can be initiated for telemetry parameters with multiple components.

Note: Examples of subsequent processing would include limit sensing, EU conversion, etc.

F-TLM-00730 The FOS shall extract all components for a telemetry parameter from the same packet.

Note: The quality of the parameter composite value will be based upon the quality of all components.

F-TLM-00735 The FOS shall be capable of extracting a maximum of 32 bits for any one telemetry parameter.

Note: The exact bit pattern extracted for a given parameter is referred to as the raw value.

7.2.3.3 Decommutate Context-dependent Telemetry Parameters

The FOS provides for the proper decommutation of telemetry parameters which are themselves dependent upon the value of other parameter telemetry points. An example of a context-dependent decommutation process would be that location packet (X), word (Y) represents several different parameters, depending on the current value of another parameter (Z).

F-TLM-00810 The FOS shall provide decommutation of a given location of a given packet to be associated with any one of various parameter mnemonics, depending on the value of a discrete telemetry context switch parameter.

Note: The context switch may be either a telemetered or derived discrete parameter.

F-TLM-00815 The FOS shall support up to sixteen (16) distinct, predefined ranges for each context switch parameter.

Note: Data base validation will disallow any undefined context switch parameter states. The sixteen context switches will encompass all possible switch parameter values.

F-TLM-00820 The FOS shall only decommutate a context-dependent parameter when the context switch is of good quality and has been marked active.

Note: If a context switch is poor quality or has been marked static, the context-dependent parameter will be marked static.

7.2.3.4 Perform Derived Parameter Calculations

The FOS will provide a pseudotelemetry processing capability that accommodates special computations using predefined algorithms. These simple calculations will be done via derived parameters. Derived parameters are built by combining existing parameters via arithmetic or logical functions. It will be possible to use predefined analog, discrete, constant, or other derived values as a source to build a new derived parameter.

F-TLM-01310 The FOS shall evaluate derived parameters based on specified, predefined equations.

Note: The derived parameter algorithms will be obtained from telemetry data base definitions.

F-TLM-01315 The FOS shall use analog telemetry values, discrete telemetry values, constants, or other derived parameters to build new derived parameters.

Note: The FOS telemetry data base will limit the number of input parameters for each derived parameter equation to six (6).

The maximum number of derived parameters that may be processed at any given time will be determined for each mission.

F-TLM-01320 The FOS shall be capable of using either raw or converted values when evaluating derived telemetry parameters.

Note: The telemetry parameter values used as inputs to the derived parameter equation will be specified as either raw or converted via the telemetry data base.

F-TLM-01325 The FOS shall support the use of basic arithmetic operators when building the derived parameters. The allowable arithmetic operators shall include:

+	Addition
-	Subtraction
-	Negation
*	Multiplication
/	Division
SIN	Sine
ASIN	Arcsine
COS	Cosine
ACOS	Arccosine
TAN	Tangent
ATAN	Arctangent

Note: The arithmetic operators are used to generate numerical results.

F-TLM-01330 The FOS shall support the use of basic logical operators when building the derived parameters. The allowable logical operators shall include:

=	Equal to
!=	Not equal to
<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
AND	Logical AND
OR	Logical OR
NOT	Logical NOT

Note: The logical operators are used to generate Boolean results, where a zero result represents false and all other values represent true.

F-TLM-01335 The FOS shall mark a derived parameter as having questionable quality whenever any of the input parameters are marked as questionable.

F-TLM-01345 The FOS shall flag the derived parameter as static if any of the input parameters are static.

Note: The FOS will not perform an algorithm when a parameter marked static is required for use in that algorithm, and the previous result shall be marked static.

F-TLM-01350 The FOS shall evaluate derived parameters in the specified order.

Note: The order is based upon the specified re-evaluation (update) rates of the parameters and how the derived parameters were organized within the data base.

F-TLM-01355 The FOS shall allow individual derived parameter evaluations to be enabled or disabled.

F-TLM-01360 The FOS shall provide the capability to adjust individual derived parameter re-evaluation rates based on a user specified interval.

Note: Derived parameter processing will be invoked after the update interval for that parameter has been modified, and every Nth time interval thereafter, N being the interval in spacecraft clock seconds.

F-TLM-01365 The FOS shall support a derived parameter evaluation interval of no less than one (1) spacecraft clock second.

Note: The evaluation interval will be based on the spacecraft clock time extracted from the telemetry packets. This provides for the consistent evaluation of derived parameters whether they are being processed at the real-time or some alternate replay rate.

7.2.3.5 Check High/Low and Delta Limit Values

The FOS has the capability of delta value checking any decommutated telemetry or derived parameter associated with data base defined delta limits. A delta value is the maximum change expected between successive samples of a parameter. Delta values are established in the telemetry data base on an individual telemetry point basis.

The FOS also has the capability to apply range checking to analog and discrete parameters using up to four groups of red and yellow high/low limit values obtained from the telemetry data base. Range checking may be performed on raw (or EU converted for analog) values whenever range limits have been defined in the Project Data Base.

F-TLM-01010 The FOS shall perform high/low limit checking on parameters when limits have been defined.

F-TLM-01015 The FOS shall have the capability to limit check parameters for red high, red low, yellow high, and yellow low boundary violations.

F-TLM-01020 The FOS shall allow for the selection of a single boundary limit group from a limit set containing up to four groups of boundary limits per parameter.

Note: Each boundary limit group is capable of accommodating red and yellow high/low limit values.

F-TLM-01025 The FOS shall provide the capability to select a boundary limit group based upon the value of an associated predefined discrete telemetry parameter.

Note: This capability permits a context switched boundary group selection. Up to sixteen (16) predefined switch ranges are available. The discrete may be either a decommutated or derived telemetry parameter.

F-TLM-01030 The FOS shall provide the capability for the user to select a predefined boundary limit group.

F-TLM-01035 The FOS shall use high and low limit values in raw or EU counts as specified for decommutated and derived parameters when limits have been defined.

Note: Limits for both decommutated and derived parameters are specified through the Project Data Base.

F-TLM-01040 The FOS shall limit check telemetry data against its associated limit values for every occurrence of the parameter.

F-TLM-01045 The FOS shall compare the change of successive raw parameter values with the predefined delta value.

Note: Delta limits are specified through the Project Data Base.

F-TLM-01050 The FOS shall perform limit checking only on good quality data.

F-TLM-01055 The FOS shall mark each telemetry parameter indicating the current limit condition.

Note: Each parameter will have flags indicating whether any limit violations have occurred. These flags include high/low (if applicable) and delta limit violations.

7.2.3.6 Report Limit Conditions

Limit condition changes are reported to the FOS. A notification is generated each time a parameter crosses a limit threshold value (when it exceeds a limit or when it comes back within a limit). A change in limit state may cause a notification to be output for display and/or logging. Notification is also provided during the time a parameter remains out of limits. The notification frequency is determined by the limit sense interval for the parameter.

F-TLM-01110 The FOS shall notify the user when a parameter violates high/low limits.

F-TLM-01115 The FOS shall notify the user when a parameter returns to within high/low limits.

F-TLM-01120 The FOS shall notify the user when a parameter incurs a delta limit violation.

F-TLM-01125 The FOS limit notification shall contain the current packet spacecraft time stamp, telemetry mnemonic, parameter value, limit condition, and assigned limit values.

Note: Every notification (event) message is tagged with a ground time stamp. Additionally, each limit notification message will include the spacecraft time stamp within the message text field.

F-TLM-01130 The FOS limit notification shall be reported when a telemetry point exceeds a limit, when the point comes back in limits, and every Nth occurrence (based upon the limit sense interval).

F-TLM-01135 The FOS shall generate a notification without an alarm for limit violations in the yellow range.

F-TLM-01140 The FOS shall generate a notification with an alarm for limit violations in the red range.

Note: An alarm reflects the severity of the violation and may trigger an audible indicator, the display of high-lighted text, etc.

F-TLM-01145 The FOS shall be capable of reporting limit violations based upon a predefined limit sense interval for each normal and derived parameter that has defined limits.

Note: The limit sense interval modifies only the notification reporting rate and has no affect on limit checking and indicator updates. The FOS will use the predefined limit interval values as the initial default limit notification period.

F-TLM-01150 The FOS shall provide notification of any out-of-limits status every Nth sample occurrence, where N is defined as the limit sense interval for that parameter.

F-TLM-01155 The FOS shall provide the capability of disabling (suppressing) or enabling notification messages concerning limits for all parameters.

Note: Although the display of notification messages may be suppressed, the messages will continue to be stored or logged. The FOS default limit condition reporting mode will be 'enabled'.

F-TLM-01160 The FOS shall provide the capability of disabling or enabling notification messages concerning limits at the parameter level.

F-TLM-01165 The FOS shall provide the capability of disabling or enabling notification messages concerning limits at the spacecraft subsystem/instrument level.

7.2.3.7 Adjust Parameter Limit Values

Parameter limit values are adjustable during operations. Such adjustments neither cause a permanent change in the Project Data Base nor are recovered during system reinitialization.

F-TLM-01210 The FOS shall provide the user the capability of changing limit values, delta limit values, and limit sense intervals.

Note: Changing of the limit values via user directive is temporary. Permanent alterations may be accommodated through changes in the limit values resident within the Project Data Base. Whenever a new set of limits is loaded, the data base defined limits and sense intervals will be restored.

F-TLM-01215 The FOS shall provide the user the capability to access current limit values and delta limit values in both raw and engineering units.

Note: Where conversions from engineering units to raw results in a non-unique value, the value will be disallowed and discarded.

F-TLM-01220 The FOS shall allow adjustment of limit values only for those telemetry parameters that have predefined limit values.

F-TLM-01225 The FOS shall be able to modify boundary limit values, delta limit values, and limit sense intervals at the parameter level.

F-TLM-01230 The FOS shall provide the capability to specify limit adjustments in raw counts or engineering units.

F-TLM-01235 The FOS shall allow for adjusting the limit values of any boundary limit group for parameters having multiple boundary limit groups defined.

Note: The telemetry data base values are restored when a new limit group is loaded or upon initialization.

7.2.3.8 Convert to Engineering Units (EU)

The FOS provides the capability to convert decommutated telemetry data from raw counts to engineering units (EUs). Conversions are performed using predefined calibration coefficients and may be based upon the following:

a. Seventh order or lower polynomial functions
b. Linear interpolation and line segment approximations of up to 15 segments (using 15 pairs of start and end-points) per conversion.

Both raw and EU converted values will be accessible to the users.

F-TLM-00910 The FOS shall allow one predefined EU conversion algorithm to be active for each parameter.

F-TLM-00915 The FOS shall allow for the selection from up to four (4) EU conversion algorithms for each parameter.

F-TLM-00920 The FOS shall provide the capability to select an EU conversion algorithm based upon the value of an associated predefined discrete telemetry point.

Note: This capability permits a context switched EU conversion. Up to sixteen (16) predefined switch ranges are available. The discrete may be either a decommutated or derived telemetry parameter.

F-TLM-00925 The FOS shall provide the capability for the user to select a predefined EU conversion algorithm.

F-TLM-00935 The FOS shall be capable of performing EU conversions using seventh order or lower polynomials with a minimum of two coefficients.

Note: Polynomial conversion will use the following equation:

$y = C_0 + C_1 x + C_2 x^2 + ... C_7 x^7$

where x is the raw value, C_i is a data base defined coefficient, and y is the converted value.

F-TLM-00945 The FOS shall be capable of performing EU conversions using linear interpolation with no more than 15 pairs of start and end-points that specify 15 contiguous line segments of increasing value.

Note: Linear interpolation conversion will use the following equation:

$y = mx + b$

where x is the raw value, m is the slope of the given segment, b is the y-axis intercept, and y is the converted value.

F-TLM-00960 The FOS shall mark accordingly any telemetry parameter that results in an error during the EU conversion process.

Note: For example, conversion errors could occur in the case of overlapping line segment end points. Such errors should be eliminated during telemetry data base validation.

F-TLM-00970 The FOS shall provide the capability for the user to adjust the predefined EU conversion algorithm coefficient values.

Note: Changing of the coefficient values via user directive is temporary. Permanent alterations may be accommodated through changes in the coefficient values resident within the Project Data Base. Whenever a new set of limits is loaded, the data base defined values will be restored.

7.2.3.9 Access Decommutated Telemetry

The most recently decommutated value for each spacecraft or instrument telemetry parameter is available for display and other application software access.

F-TLM-01410 The FOS shall make available the values for every predefined telemetry parameter.

F-TLM-01415 The FOS shall make available the status for every predefined telemetry parameter.

F-TLM-01420 The FOS shall retain the parameter data until replaced by more recent data and/or system reconfiguration.

F-TLM-01425 The FOS shall make available, on a per-parameter basis, the following:

a. last decommutated raw value
b. associated converted value (if applicable)
c. limit range values (if applicable)
d. limit sense interval
e. no data available indicator
f. static/active indicator
g. quality status indicator
h. out-of-limits low indicators (if applicable)
i. out-of-limits high indicators (if applicable)
j. delta limit error indicator
k. conversion error indicator

Note: Reference section 7.2.3.8 for discussion of conversion errors.

F-TLM-01430 The FOS shall initialize/baseline all decommutated and converted value areas when no telemetry data is available.

Note: For example, this would occur during pre-contact system configuration when telemetry data is yet to be received.

7.2.4 Telemetry Store and Replay

The EOC will have the ability to store and replay telemetry data that has been received from EDOS. The data may be either telemetry received in real-time during a contact, or telemetry that is captured at EDOS and played back to the EOC.

7.2.4.1 Store Real-time and Spacecraft Recorder Telemetry

The EOC has the capability of storing the downlinked real-time and spacecraft recorder playback housekeeping and instrument engineering telemetry.

F-TLM-01510 The EOC shall store telemetry data as received from EDOS.

Note: Telemetry data is received from EDOS in the form of EDUs containing spacecraft and instrument CCSDS telemetry packets.

F-TLM-01515 The EOC shall be capable of receiving and storing real-time housekeeping telemetry at rates up to 50 Kbps for each EOC controlled spacecraft.

F-TLM-01520 The EOC shall be capable of receiving and storing spacecraft recorder playback housekeeping telemetry at rates up to 1.544 Mbps for each EOC controlled spacecraft.

Note: Spacecraft recorder playback data is received rate-buffered from EDOS (via file transfer).

F-TLM-01525 The EOC shall be capable of receiving and storing real-time instrument engineering telemetry at rates up to 50 Kbps for each EOC controlled spacecraft.

F-TLM-01530 The EOC shall be capable of receiving and storing spacecraft recorder playback instrument engineering telemetry at rates up to 1.544 Mbps for each EOC controlled spacecraft.

Note: See mission specific requirement.

F-TLM-01535 The FOS shall notify the user when the start of a spacecraft recorder playback collection is recognized.

Note: Storage of spacecraft recorder data is started at this time.

F-TLM-01540 The FOS shall notify the user when the completion of a spacecraft recorder playback collection is recognized.

Note: Storage of spacecraft recorder data is stopped at this time.

F-TLM-01545 The EOC shall provide the capability to enable and disable the storage of housekeeping and instrument engineering telemetry.

7.2.4.2 Replay Stored Telemetry

Stored real-time and spacecraft recorder history telemetry may be processed by specifying the desired spacecraft, data type, start and optional stop times, and replay rate. Replay operations simulate real-time telemetry processing, including limit and delta limit checking, and will likewise permit the generation of derived parameters.

F-TLM-01610 The FOS shall replay telemetry data based upon a user specified time period.

F-TLM-01625 The FOS shall process all telemetry packets for the requested period, during the replay operation.

F-TLM-01630 The FOS shall be capable of processing stored housekeeping and engineering telemetry for analysis at twelve (12) times the real-time rate.

Note: This requirement is derived from the fact that the FOS must be able to analyze twenty-four (24) hours of stored telemetry data within two (2) hours. This capability is used for off-line batch processing and when the immediate display of information is not necessary or desired (i.e. gathering statistics on a particular parameter over several weeks of stored telemetry data).

F-TLM-01635 The FOS shall be capable of processing stored housekeeping and engineering telemetry for display at rates up 150 Kbps.

Note: This requirement permits the rapid replay and display of stored telemetry, and may be useful during contact simulations.

F-TLM-01640 The FOS shall be able to replay and process the telemetry data at the real-time or at a user specified rate.

7.2.5 Special Data Collection and Processing

The EOC provides capabilities to collect spacecraft and instrument memory dumps, collect spacecraft attitude information for transfer to the Flight Dynamics Facility (FDF), and collect and process information used for calibrating the spacecraft clock. Also provided is the ability to check the current state of the spacecraft (via telemetry) against a specified expected state.

7.2.5.1 Collect Spacecraft and Instrument Computer Memory Dump

The EOC provides the capability of collecting and storing the contents of spacecraft and instrument computer memory.

F-TLM-01710 The EOC shall be capable of accepting and storing the downlinked spacecraft or instrument computer memory dump.

Note: For a given spacecraft, the spacecraft and instrument memory dumps are assumed to be of identical format and will be handled by the EOC in a similar manner.

F-TLM-01715 The EOC shall detect the start of a computer memory dump and collect the dumped memory data (including fill).

F-TLM-01720 The EOC shall store each computer memory dump collection separately.

F-TLM-01725 The FOS shall notify the user when the start of a computer memory dump collection is recognized.

F-TLM-01730 The FOS shall notify the user when the completion of a computer memory dump collection is recognized.

7.2.5.2 Collect Spacecraft Attitude Data

The EOC will be capable of collecting attitude and related spacecraft data for transfer to the Flight Dynamics Facility (FDF). The parameters will be extracted from the spacecraft housekeeping telemetry data which may be sampled at different frequencies and displaced over many housekeeping data packets. The information collected with each sample can include the parameter mnemonic, parameter value, parameter format indicator (raw or EU), parameter quality indicators, and time tag (refer to 510-4ICD/0493 for an example of a potential collection format). Collection of information may occur either in real-time or during the replay of stored housekeeping telemetry.

F-TLM-01810 The EOC shall provide the capability to collect predefined parameter data from the spacecraft housekeeping telemetry.

F-TLM-01815 The EOC shall provide the capability to collect telemetry parameters based upon a user specified time period.

Note: The parameters may be collected from either real-time or stored historical telemetry data.

F-TLM-01820 The EOC shall provide the capability to collect parameter values as raw or EU converted values.

F-TLM-01825 The EOC shall provide the capability to format and forward data to the FDF as the parameters are being extracted from telemetry.

F-TLM-01830 The EOC shall provide the capability to format and store data as the parameters are being extracted from telemetry.

F-TLM-01835 The EOC shall provide the capability of simultaneously storing the data while forwarding the data to the FDF.

7.2.5.3 Compare Expected Spacecraft State with Telemetry

To assist in back-orbit command verification, the EOC can monitor and compare the spacecraft against its expected state.

F-TLM-02110 The EOC shall compare expected values of specified parameters with the actual values received in the telemetry stream.

F-TLM-02115 The EOC shall perform spacecraft state checking only on good quality telemetry data.

F-TLM-02120 The EOC shall perform spacecraft state checks for discrete telemetry values that can be changed via spacecraft command and that can be verified through housekeeping telemetry.

F-TLM-02125 The EOC spacecraft state check shall reveal any deviations between the current state and expected state.

F-TLM-02130 The EOC shall report the differences between the expected and actual spacecraft states.

Note: Any differences will be reported as notification messages.

F-TLM-02135 The EOC shall provide the capability for the user to invoke spacecraft state checking.

F-TLM-02140 The EOC shall provide the capability to baseline the expected spacecraft state values with current downlink telemetry.

Note: The table of expected spacecraft parameter values can be over-written with the current spacecraft telemetry values. If necessary, the user is then permitted to invoke the spacecraft check several times during a contact.

7.2.6 Non-telemetry Message Processing

The EOC processes certain non-telemetry messages that assist in assessing spacecraft contact service sessions provided by EDOS. The EOC also processes non-telemetry messages that aid EOC spacecraft clock calibration and correlation computations.

7.2.6.1 Process Non-telemetry Messages

The EOC provides the capability to receive and process non-telemetry messages. (Reference EDOS Functional and Performance Requirements 560-EDOS 0202.0001, EDOS Operations

Concept 560-EDOS 0106.0002, Interface Control Document between GSFC Mission Operations Centers and the Network Control Center Data System 530-ICD-NCCDS/MOC.)

F-TLM-02210	The EOC shall be capable of receiving and processing EDOS TDRSS Service Session (TSS) summary reports following the completion of the TSS.
F-TLM-02215	The EOC shall be capable of receiving and processing EDOS real-time Customer Operations Data Accounting (CODA) service reports periodically during a TSS.
F-TLM-02220	The EOC shall be capable of receiving and processing EDOS rate buffered delivery records.
F-TLM-02235	The EOS shall be capable of receiving and processing status information from the DSN. Note: DSN status information will be received in the form of monitor blocks.
F-TLM-02240	The EOC shall be capable of receiving and processing status information, as available, from the GN.
F-TLM-02245	The EOC shall be capable of receiving and processing status information, as available, from the WOTS.
F-TLM-02250	The EOC shall be capable of storing non-telemetry messages as they are being received.

7.3 Command Subsystem

The Command Subsystem provides the capability to: validate, build, uplink and verify real-time commands for the EOS spacecraft and instruments: uplink and verify memory loads for the EOS spacecraft and instruments; and verify execution of stored commands for the EOS spacecraft and instruments during a real-time contact.

Note: The level 3 requirements document makes reference to "command groups", which this document cites as "command procedures".

This section is organized as follows:

7.3.1 Command Providers

7.3.1.1 Transmission configurations

The EOC will have the capability to transmit commands to the EOS spacecraft using the SN, GN, DSN or WOTS via the EDOS interface. Additionally, the EOC will allow for commanding of the spacecraft simulator.

F-CMD-01120 The EOC shall be capable of transmitting commands to the EOS spacecraft via EDOS using the SN (Space Network).

F-CMD-01125 The EOC shall be capable of transmitting commands to the EOS spacecraft via EDOS using the GN (Ground Network) in contingency or emergency operations.

F-CMD-01130 The EOC shall be capable of transmitting commands to the EOS spacecraft via EDOS using the DSN (Deep Space Network) in contingency or emergency operations.

F-CMD-01135 The EOC shall be capable of transmitting commands to the EOS spacecraft via EDOS using the WOTS (Wallops Orbital Tracking System) in contingency or emergency operations.

F-CMD-01160 The EOC shall be capable of transmitting commands to EDOS via Ecom.

F-CMD-01165 The EOC shall be capable of transmitting commands to the spacecraft simulator.

7.3.1.2 Uplink Rates

The EOC will support all mission uplink rates. The various data rates are associated with command configurations which are used to select the appropriate data rate. F-CMD-01230The EOC shall provide the capability to uplink commands at a rate selected by the user from a set of valid rates.

F-CMD-01250 The EOC shall implement command spacing (metering) to maintain the required real time uplink rate.

7.3.1.3 Command Types

The EOC will be capable of transmitting operator input commands, command procedures, ground scripts, and command loads. Command procedures and ground scripts will be processed identical to operator input commands. Instrument commands and spacecraft commands will be processed identically. Inasmuch as the commands are being processed by a single processing stream, the commands from these different sources will be merged into a single uplink stream.

Note: the verification of stored spacecraft commands is addressed under "Verification of Commands"

F-CMD-01310 The EOC shall permit an authorized EOC operator to issue individual commands, in real time.

F-CMD-01315 The EOC shall be capable of transmitting commands from a command procedure consisting of one or more commands.

F-CMD-01317 The EOC shall be capable of transmitting commands from a ground script.

F-CMD-01320 The EOC shall merge spacecraft and instrument commands, and spacecraft and instrument memory loads into one uplink stream.

Note: An active load must be killed before operator commands will be accepted.

F-CMD-01325 The EOC shall be capable of transmitting predefined Absolute Time Command (ATC) loads.

F-CMD-01330 The EOC shall be capable of transmitting predefined Relative Time Sequence (RTS) loads.

F-CMD-01335 The EOC shall be capable of transmitting flight software loads.

F-CMD-01340 The EOC shall be capable of transmitting table loads.

Note: The table loads may be for either the spacecraft, or an instrument.

F-CMD-01345 The EOC shall be capable of transmitting instrument microprocessor loads.

7.3.2 Command Generation

7.3.2.1 CCSDS Protocol Support

For each spacecraft and its instruments, uplink data that conform to the CCSDS Telecommand Standard will be prepared.

The EOC will transmit uplink data conforming to Command Operations Procedure-1 (COP-1) and Frame Operations Procedure-1 (FOP-1) transmission verification mechanisms.

F-CMD-02110 The EOC shall assemble standard, fixed length packets from the command structures formatted for on board execution.

Note: This packet format is specified in CCSDS 202.0-B-2, Telecommand Part 2 Data Routing Service, of November, 1992.

F-CMD-02120 The EOC shall encase packets within a command link transmission unit (CLTU).

Note: This is specified in CCSDS 202.0-B-2, Telecommand Part 2 Data Routing Service, of November, 1992.

F-CMD-02125 The EOC shall monitor command link control words (CLCWs) from the spacecraft to ascertain status of the command link.

Note: This is specified in CCSDS 202.1-B-1, Telecommand Part 2.1 Command Operation Procedures, of October 1991.

F-CMD-02130 The EOC shall support the generation of FARM control commands.

Note: These are specified in CCSDS 202.1-B-1, Telecommand Part 2.1 Command Operation Procedures, of October 1991.

7.3.2.2 Generation of Commands

The EOC will provide the capability to build real-time mnemonic formatted commands based on operator input.

F-CMD-02210 The EOC shall validate all real time commands and ensure that the commands accepted conform to the command definition.

Note: These commands may be issued from either a ground script, a procedure, or as operator input.

F-CMD-02215 The EOC shall provide the capability to assemble commands from command mnemonic requests.

F-CMD-02220 The EOC shall assign default values, if available, to command data portions if not specified by the user.

F-CMD-02225 The EOC shall provide the capability to assemble commands with submnemonic specifications.

Note: Commands with submnemonic specifications are also known as serial magnitude, nondiscrete, or analog commands in other control centers.

F-CMD-02230 The EOC shall use a predefined default value for a submnemonic when one is not explicitly provided.

F-CMD-02235 The EOC shall require submnemonic values for commands having submnemonic specifications, but lacking default values.

Note: Such a command will be rejected if the command is issued without specifying a value for the submnemonic.

F-CMD-02240 The EOC shall provide the user the capability to view the most current command in binary (numeric) format.

7.3.3 Pretransmission Validations

7.3.3.1 Prerequisite State Checking

The EOC will perform data base defined prerequisite state checking of mnemonic commands prior to command uplink. Prerequisite state checking confirms spacecraft states by checking the specified telemetry values, in real time. Commands failing the check will not be transmitted to the spacecraft.

F-CMD-03110 The EOC shall provide the capability to verify up to four (4) telemetry points prior to command transmission.

Note: The database will specify which commands are to be prerequisite checked, and will provide for specification of a single range of acceptable discrete or analog values for each telemetry point.

Note: While prerequisite state checking cannot be performed on commands within a stored command load, the CMS/Planning and Scheduling subsystems do command constraint check analysis as part of the stored command building process.

F-CMD-03115 The EOC shall allow for overriding (disablement) of prerequisite checking.

F-CMD-03125 The EOC shall suppress transmission of commands which fail prerequisite checking.

F-CMD-03127 The EOC shall allow the operator to override a command prerequisite state check failure.

Note: Upon prerequisite state check failure, the operator will be prompted for override permission. If the operator's response indicates override, processing of the command will continue as though prerequisite check override had been enabled at the time the command was issued.

F-CMD-03130 The EOC shall deem as failing prerequisite check those commands referencing telemetry points that have static data values.

Note: Static data values are values which are not current; no data has been recently received.

F-CMD-03133 The FOS shall report the status of each prerequisite check to the user.

F-CMD-03135 The FOS shall report to the user the mnemonic, required values, current values, and current state which cause a prerequisite check to fail.

7.3.3.2 Critical Commands

The EOC will provide the capability to control the uplink of critical commands by requiring a second positive response from the operator. If a command procedure or ground script is being executed, authorization is required for each critical command to be uplinked.

F-CMD-03210 The EOC shall determine a specific command as critical based on a its definition.

Note: This definition is contained within the data base.

F-CMD-03215 The EOC shall require a user authorization (allow or cancel) prior to uplinking a critical command, regardless of its origin (operator input, command procedure, or ground script).

F-CMD-03220 The EOC shall require a user to enter a single authorization (allow or cancel) prior to uplinking a stored command load containing critical commands.

F-CMD-03225 The EOC shall prompt the user for a critical command authorization.

Note: The user will be required to respond to the critical command prompt before any further activities can be performed.

7.3.3.3 Load File Validation

The EOC provides validation of load data files by checking load information.

F-CMD-03310 The EOC shall verify existence of the load upon receipt of a load uplink request.

F-CMD-03315 The EOC shall check load data by verifying pertinent load parameters to ensure proper load identification.

Note: Pertinent load parameters include spacecraft id, date/time window and destination.

F-CMD-03320 The FOS shall notify the user of load validation failures.

7.3.3.4 Command Authorization

The EOC will ensure that there is a single point of command for the spacecraft and its instrument manifest.

F-CMD-03410 The EOC shall verify prior to acceptance of a command that the command was issued from the user currently having the command authority.

Note: This insures that each spacecraft has only a single point of command.

F-CMD-03420 The EOC shall verify prior to acceptance of a command that the operator issuing the command has authorization for that specific command.

Note: Each operator will have a set of authorized commands which that operator is entitled to issue. For example, an ICC is restricted to its suite of instrument commands, and cannot issue spacecraft commands.

7.3.4 Command Transmission

7.3.4.1 Command Processing

F-CMD-04110 The EOC shall process and output to ECOM a single real-time emergency command request within 500 milliseconds of receiving the request from an EOC operator.

F-CMD-04115 The EOC shall archive all uplinked information, in the format transmitted from the EOC.

Note: I.E. The command blocks will be archived in the format sent to EDOS.

F-CMD-04120 The FOS shall notify the user when a command is transmitted.

F-CMD-04130 The FOS shall notify the user when a load is transmitted.

7.3.4.2 Command Retransmission

The EOC will provide for automatic retransmission of commands which were unsuccessfully transmitted.

Commands are retransmitted when it is recognized (through CCSDS COP-1 protocol) that (one or more) commands were not successfully transmitted to the spacecraft.

F-CMD-04210 The EOC shall provide for the automatic retransmission of CLTUs once it has been determined that command(s) have been lost.

F-CMD-04215 The EOC shall implement retransmission such that all commands transmitted since the last command known to be received and accepted at the spacecraft shall be retransmitted in the same order as originally transmitted.

F-CMD-04220 The EOC shall provide a predefined, operator overridable retransmission count to limit the number of retransmissions attempted.

F-CMD-04225 The EOC shall permit the operator to disable command retransmission.

Note: Specifying a retransmission count value of zero effectively disables retransmission.

F-CMD-04230 The EOC shall provide the capability to set the next expected ground frame sequence number to a user specified value.

Note: This capability is provided to permit resynchronization of the ground and spacecraft frame sequence numbers. It is permitted only when command transmission is not in progress.

7.3.5 Verification of Commands

Commands are verified in two ways. Command receipt verification verifies that uplinked commands were received intact on board the spacecraft. This is accomplished through the CCSDS protocol. Telemetry verification verifies that the commands were successfully executed. This is accomplished by checking real time telemetry after allowing sufficient time for the command to execute, and the telemetry to downlink.

7.3.5.1 Command Receipt Verification

Command receipt verification is provided by the receipt of the Command Link Control Word (CLCW) of the CCSDS processing.

F-CMD-05110 The EOC shall provide the capability to verify via COP-1 the successful receipt of real time commands by the spacecraft.

Note: Only type AD commands are verified through COP-1 processing.

F-CMD-05115 The EOC shall notify the operator of the status of each command uplinked, as success or fail.

7.3.5.2 Telemetry Verification

The EOC will provide the ability to verify that real time commands have been received and processed by the appropriate spacecraft subsystem or instrument by examining the real time telemetry.

F-CMD-05220 The EOC shall provide the capability to verify via telemetry the successful execution of spacecraft commands by checking in real time the status of a single telemetry point.

Note: The database will specify which commands are to be telemetry verified, and will provide for specification of a single range of acceptable discrete or analog values for the telemetry point.

F-CMD-05225 The FOS shall notify the operator of spacecraft command telemetry verification status.

F-CMD-05230 The EOC shall provide the capability to verify via telemetry the successful execution of instrument commands.

F-CMD-05235 The FOS shall notify the operator of instrument command telemetry verification status.

F-CMD-05245 The EOC shall allow a pre-defined duration time after receipt verification before determining that a command has failed telemetry verification.

Note: The pre-determined time is defined per command, and is based upon onboard execution time; transmission time is not taken into account. This is because the verification wait period does not begin (in real time) until after the CLCW has been received; the transmission delay period for the CLCW is identical to that for the telemetry, and this accounts for the transmission delay.

F-CMD-05247 The EOC shall check telemetry values for all outstanding commands needing telemetry verification at intervals of no more than a pre-defined number of seconds.

Note: This gives the EOC the capability to determine that a command is telemetry verified, prior to the pre-defined duration time. The pre-defined duration is specified in the database. For example, if the duration time for a particular command is one minute and the interval time is specified as five seconds, the command could be telemetry verified in as little as five seconds after uplink verification. This same command, however, would not be considered to have failed telemetry verification unless the one minute duration lapses without the command being telemetry verified.

F-CMD-05250 The EOC shall provide the capability to verify via telemetry the successful receipt of a load.

F-CMD-05255 The FOS shall notify the operator of load telemetry verification status.

Note: Supplemental information available for display for the load telemetry verification status includes the CRC from the load initiate command, and (if available) a display of the CRC telemetered from the spacecraft.

7.3.5.3 External ICC Commanding Notifications

F-CMD-05310 The EOC shall provide the IP-ICC with a final instrument uplink status, with a failure status to indicate the point of failure.

Note: the following are examples of possible status:

- rejected by EOC
- transmitted, not received by spacecraft
- received by spacecraft; unsuccessfully executed

  (or)
- dispatched to instrument; unsuccessfully executed
- successfully executed

7.3.5.4 ICC Emergency Notification

F-CMD-05410 The EOC shall provide an IP-ICC with instrument command notification messages, when emergency or contingency instrument commands are issued by other than the IP-ICC.

Note: For example, by the EOC.

7.3.5.5 Telemetry Verification of Stored Commands

Commands are forwarded by the command subsystem at a time corresponding to their execution on board the spacecraft. Although transmission, retransmission and prechecking of these commands is suppressed, verification of stored commands is otherwise identical to that for real time commands.

F-CMD-05510 Stored commands shall be telemetry verified as they execute on board the spacecraft during a real time contact.

8. Analysis

Section 8 contains the requirements associated with the subsystem that provides services used for the FOS activity phases. This includes the Analysis subsystem.

The FOS will provide analysis capabilities to maintain the health and safety of the EOS spacecraft and its instruments. The analysis functions will provide the FOT with the tools necessary to perform spacecraft systems management, performance analysis, trend analysis, FDIR (Fault Detection, Isolation, and Recovery), configuration management, and management of the S/C resources. These functions will be provided on a noninterference basis with the real-time telemetry processing functions.

An infrastructure will be provided which the FOT can use to develop customized analysis tools. This infrastructure includes tools for generating plots and reports, writing algorithms, ingesting external data, generating carry-out data, trending, and writing operations procedures.

This section is organized as follows:

8.1 Data Access

All housekeeping telemetry data, all statistical data generated automatically by the FOS, all relevant FDF, NCC and EDOS data, and all FOT stored dataset files will be available as input into the analysis process. The FOS will provide for the retrieval of data from the DAAC in a manner transparent to the user.

F-ANA-01010 The FOS shall be able to access all archived telemetry data for analysis.

Note:The archived telemetry data would need to be in an FOS standard format. It is also required that the applicable data base be provided as well.

F-ANA-01020 The FOS shall be able to access all user generated MMM statistics data files for analysis.

Note: MMM refers to the minimum value, the maximum value and the mean value for a defined time interval. Along with these values, the standard deviation and number of samples will also be maintained.

F-ANA-01025 The FOS shall be able to access all system generated statistics data files for analysis.

Note: System generated statistics includes MMM statistics based on orbital, daily, monthly, and mission to date intervals, out of limits information based on daily and monthly intervals, and discrete parameter state change information based on daily and monthly intervals.

F-ANA-01030 The FOS shall allow the user to access a previously saved dataset for analysis.

Note:A dataset is defined to be user specified data from a contiguous period of time from a single spacecraft. The dataset will have a standardized format which is described in the FOS Design Specification and FOS Database Design and Database Schema Specifications Document.

F-ANA-01040 The FOS shall be able to access FDF supplied data for analysis.

F-ANA-01050 The FOS shall be able to access NCC User Performance Data (UPD) for analysis.

F-ANA-01060 The FOS shall be able to access EDOS Customer Operations and Data Accounting (CODA) messages for analysis.

8.2 Data Base Usage

The FOS will store all valid data bases and make these available for analysis of historical data. This will ensure that as data is requested for analysis, the valid data base for the time interval requested will be utilized to process the data unless otherwise requested by the user.

F-ANA-02010 The FOS, by default, shall determine the appropriate data base to use for processing each request for data analysis.

F-ANA-02030 The FOS shall have the capability to utilize more than one valid data base if the time interval requested for data analysis spans an interval during which more than one database was utilized for operations.

F-ANA-02040 The FOS shall, by default, only use a data base for processing analysis requests during the time interval in which the database was being used operationally.

F-ANA-02050 The FOS shall provide the capability to override the automatic data base selection by the system and process an analysis request using a data base specified by the user.

Note:The user specified database can be any FOS validated database.

8.3 Analysis Requests

The FOS will provide the capability to process requests for the analysis of data. During the processing of the request the FOS will ensure that the information provided by the user is valid. The user will be notified of any errors or discrepancies. For a detailed description of the contents of analysis requests, refer to Section 9.1.9.1.

F-ANA-03010 The FOS shall be able to perform analysis on all telemetry parameters contained within the telemetry archive.

F-ANA-03015 The time span for the analysis shall be one second or greater.

F-ANA-03020 The FOS shall verify that for user supplied start and stop times, the stop time is greater than the start time.

F-ANA-03030 The FOS shall notify the user of any mnemonic that has been requested for analysis and is found to be invalid for the specified mission.

F-ANA-03040 The FOS shall provide notification for every telemetry mnemonic requested for analysis which is not valid for the time interval requested.

F-ANA-03050 The FOS shall perform analysis on all requested telemetry parameters which have at least one sampling within the specified time interval.

Note: Types of analysis allowable in an analysis request are defined in Section 9.1.9.1

F-ANA-03060 If a telemetry parameter requested for analysis does not occur within the requested time span, all reports and plots containing a reference to the parameter shall indicate that the parameter was not found .

F-ANA-03070 The FOS shall by default use data flagged as good quality in routine analysis.

F-ANA-03080 The FOS shall allow the user to request the use of data with questionable quality in routine analysis.

F-ANA-03100 The FOS shall provide the capability to process a request for telemetry MMM data at daily resolution for any time span greater than or equal to one day and up to the life of the specified mission.

F-ANA-03110 The FOS shall provide the capability to process a request for telemetry MMM data at monthly resolution for any time span greater than or equal to one month and up to the life of the specified mission.

F-ANA-03120 The FOS shall provide the capability process a request for telemetry MMM data at orbit night resolution for any time span greater than or equal to one orbit and up to the lifetime of the mission.

F-ANA-03125 The FOS shall provide the capability process a request for telemetry MMM data at orbit day resolution for any time span greater than or equal to one orbit and up to the lifetime of the mission.

F-ANA-03130 The FOS shall provide the capability process a request for telemetry MMM data at full orbit resolution for any time span greater than or equal to one orbit and up to the lifetime of the mission .

F-ANA-03135 The FOS shall provide the capability to uniquely time tag parameters to the granularity of 1 milliseconds.

F-ANA-03140 The FOS shall check for the existence of all specified mnemonics whenever a new telemetry data base, (start of the request or data base crossover), is encountered during the processing of the data analysis request.

Note:A data base crossover is the point in time when a new version of the data base replaces the current version and is now considered the operational data base. The time at which this occurs is maintained in the system thus allowing the appropriate data base to be utilized when analyzing historical data.

F-ANA-03150 The FOS shall log a message to the history log if a specified mnemonic is no longer valid after a data base crossover.

F-ANA-03160 The FOS shall check for the validity of a requested EU conversion (existence of a defined conversion) whenever a new telemetry data base, (start of the request or data base crossover), is encountered during the processing of a data analysis request.

F-ANA-03170 The FOS shall provide notification if a specified mnemonic no longer has a data base defined EU conversion after a data base crossover.

F-ANA-03180 The FOS shall provide the capability to process a request for discrete parameter state change statistics data at daily resolution for any time span greater than or equal to one day and up to the lifetime of the mission

F-ANA-03190 The FOS shall provide the capability to process a request for discrete parameter state change statistics data at monthly resolution for any time span greater than or equal to one month and up to the lifetime of the mission .

F-ANA-03200 The FOS shall provide the capability to process a request for out of limits statistics data at daily resolution for any time span greater than or equal to one day and up to the lifetime of the mission .

F-ANA-03210 The FOS shall provide the capability to process a request for out of limits statistics data at monthly resolution for any time span greater than or equal to one month and up to the lifetime of the mission .

8.4 Analysis Products

8.4.1 Dataset

A dataset is a collection of requested parameters which is used to generate an analysis result such as a plot, report, or carry-out data. Datasets can be stored and retrieved as needed. They are a standardized file which is used to produce the requested output.

F-ANA-04010 The FOS shall build a dataset in response to a request for data analysis.

F-ANA-04020 The FOS shall be able to generate datasets from the following S/C telemetry:

a. Stored real-time housekeeping telemetry data

b. S/C recorder housekeeping data

c. Engineering data

Note: S/C data is stored in a merged archive of real-time and recorder data. Since this merged archive contains both types, the datasets generated may also contain both, depending on the time span of the dataset.

F-ANA-04025 The FOS shall be able to generate datasets from statistical data.

F-ANA-04030 The FOS shall be able to generate datasets from the following FDF data:

a. Star Density profile

b. Star Interference

c. Earth Sensor Assembly (ESA) Sun/Moon Interference

d. Fine Sun Sensor (FSS) Visibility Prediction

e. TDRSS State Vectors

f. TDRSS Availability Times

g. Filter Tuning Parameters

h. Omni to TDRSS Viewing Times

i. HGA to TDRSS Viewing Times

j. Omni to Ground Station Viewing Times

k. HGA Gimbal Angles

l. Predicted Ephemeris

m. Mass and Center of Mass Location Estimates

n. Oscillator Frequency data

o. EOS Brouwer-Lyddane Elements

F-ANA-04040 The FOS shall provide the capability to generate datasets from data base defined derived parameters.

F-ANA-04050 The FOS shall provide the capability to generate a dataset from the results of a user supplied algorithm. See Section 8.6 for a description of user supplied algorithms.

F-ANA-04060 A dataset shall not be limited in size, except as limited by the amount of storage available.

F-ANA-04070 The FOS shall provide the capability to generate datasets which include any combination of one or more telemetry mnemonics for a single specified mission.

F-ANA-04080 The FOS shall provide the requested EU and/or raw value for each occurrence of each specified telemetry mnemonic in the dataset.

F-ANA-04090 The FOS shall provide the spacecraft time for each telemetry mnemonic in the dataset.

F-ANA-04100 The FOS shall provide the capability to generate datasets based on spacecraft start and stop times as specified in the request.

F-ANA-04110 The FOS shall provide the capability to generate datasets which contain telemetry values based on user specified sampling rate specified per parameter.

F-ANA-04120 The FOS shall provide the capability to generate datasets in the carryout format as specified in the FOS Design Specification and FOS Database Design and Database Schema Specifications Document.

F-ANA-04130 The FOS shall provide the capability to include the following information for each sampling in a dataset:

a. Raw value
b. EU converted value (if applicable)
c. Quality status indicator
d. Out-of-limits low indicator
e. Out-of-limits high indicator
f. Delta limit error indicator
g. Conversion error indicator
h. Invalid mnemonic indicator

Note:The invalid mnemonic indicator provides the information on whether the particular mnemonic is valid for the data base being used to analyze the data. This becomes particularly important when a request crosses data bases and a specified mnemonic is defined in one data base and not the other.

8.4.2 Performance Monitoring

The FOS will be able to determine from the individual components the overall health and configuration of each of the spacecraft subsystems and instruments.

F-ANA-04200 The FOS shall provide the capability to determine the state of each of the S/C subsystems and instruments, based on values of valid telemetry parameters.

Note:The state of a subsystem or instrument refers to its mode. Examples of states would be on, off, charging, discharging, calibration mode, etc.

F-ANA-04210 The FOS shall provide the capability to determine the status of each of the S/C subsystems and instruments, based on values of valid telemetry parameters.

Note:The status of a subsystem or instrument refers to the overall health of the component. Examples of status's would be nominal and failed.

F-ANA-04220 The FOS shall provide the capability to determine the configuration of each of the S/C subsystems and instruments, based on values of valid telemetry parameters.

Note:The configuration of a subsystem or instrument is the description of how the component is currently being utilized. Examples of configurations would be on-line and backup.

8.4.3 Reports

The FOS will be able to generate reports based upon analysis data. Several types of reports will be available depending on the type of data requested.

F-ANA-04310 The FOS shall provide the capability to build ASCII reports from the system generated telemetry MMM statistics data.

F-ANA-04315 The FOS shall provide the capability to build ASCII reports from the user specified telemetry MMM statistics data.

F-ANA-04320 Each statistics report shall contain the following header information:

a. The date and time of the report
b. The starting spacecraft time of the data
c. The ending spacecraft time of the data
d. The interval type of the MMM statistics (if applicable)

F-ANA-04330 The FOS shall provide the mnemonic name for each telemetry item specified in a statistics report.

F-ANA-04340 The FOS shall provide the capability to include the following information for each telemetry item specified as part of the telemetry statistics report:

a. Minimum value within each time interval
b. Spacecraft time for each minimum value reported
c. Maximum value within each time interval
d. Spacecraft time for each maximum value reported
e. Mean value for each time interval
f. Standard deviation
g. Number of samples occurring within each time interval

F-ANA-04350 The FOS shall provide the capability to generate a Time Ordered Downlink Report for a user specified mission.

Note: A Time Ordered Downlink Report is a listing which contains all data base defined parameters and their sampled values for the time interval specified. The report is ordered based on the position of the telemetry parameters in the downlink stream.

F-ANA-04360 The FOS shall produce a Time Ordered Downlink Report for the time interval requested by the user.

F-ANA-04370 The time interval of a Time Ordered Downlink Report shall be greater than or equal to 1 second and less than or equal to the length of a major frame.

F-ANA-04375 Each Time Ordered Downlink Report shall contain the following header information:

a. The date and time of the report

b. The starting spacecraft time of the data

c. The ending spacecraft time of the data

F-ANA-04380 The FOS shall provide all data base defined telemetry mnemonics and their respective values for the time interval requested in the Time Ordered Downlink Report. If a telemetry mnemonic has a data base defined EU conversion, the EU value will be supplied, otherwise the raw value will be supplied.

Note:This includes both analog and discrete parameters.

F-ANA-04390 The FOS shall provide the spacecraft time for each telemetry mnemonic listed in the Time Ordered Downlink Report.

F-ANA-04400 The FOS shall order the telemetry parameters in a Time Ordered Downlink Report according to a unique spacecraft time tag associated with each parameter.

F-ANA-04410 The FOS shall provide the capability to generate a Parameter Out-of-limits Report for a user specified mission.

Note:A Parameter Out-of-limits Report is a report which provides information, on a parameter by parameter basis, regarding limit violations and durations.

F-ANA-04415 Each out of limits report shall contain the following header information:

a. The date and time of the report

b. The starting spacecraft time of the data

c. The ending spacecraft time of the data

d. A list of parameters which are out of limits at the start time of the report

F-ANA-04420 The FOS shall provide for each parameter specified in a request for a Parameter Out-of-limits Report, the following information:

a. Spacecraft time for start of every limit violation

b. Duration of every limit violation which began within the time span of the report

c. Sum of durations of all limit violations within the duration of the report

d. The type of the limit violation. Violations covered are red-high, red-low, yellow-high, yellow-low, and rail

F-ANA-04430 The FOS shall generate the Parameter Out-of-limits Report for the time interval specified.

8.5 Statistics

8.5.1 System Generated Statistics

The FOS will automatically calculate a basic set of statistical data on each telemetry parameter defined in the data base. This data will be kept in the data management system and available as needed without further processing of the data.

F-ANA-05010 The FOS shall generate and store the following statistics for each telemetry mnemonic:

a. Minimum value

b. Spacecraft time for the minimum value

c. Maximum value

d. Spacecraft time for the maximum value

e. Mean

f. Standard Deviation

g. Number of samples

F-ANA-05020 The FOS shall compute statistics for full orbital intervals for each analog telemetry parameter for the life of the mission.

F-ANA-05030 The FOS shall compute statistics for full orbital intervals for each data base defined derived parameter for the life of the mission.

F-ANA-05031 The FOS shall compute statistics for orbit day intervals for each analog telemetry parameter for the life of the mission.

F-ANA-05032 The FOS shall compute statistics for orbit day intervals for each data base defined derived parameter for the life of the mission.

F-ANA-05033 The FOS shall compute statistics for orbit night intervals for each analog telemetry parameter for the life of the mission.

F-ANA-05034 The FOS shall compute statistics for orbit night intervals for each data base defined derived parameter for the life of the mission.

F-ANA-05040 The FOS shall compute statistics for daily intervals for each analog telemetry parameter for the life of the mission.

Note: Daily statistics shall be computed by summing the statistics of all full orbits which began within the calendar day.

F-ANA-05050 The FOS shall compute statistics for daily intervals for each data base defined derived parameter for the life of the mission.

Note: Daily statistics shall be computed by summing the statistics of all full orbits which began within the calendar day.

F-ANA-05060 The FOS shall compute statistics for monthly intervals for each analog telemetry parameter for the life of the mission.

F-ANA-05070 The FOS shall compute statistics for monthly intervals for each data base defined derived parameter for the life of the mission.

F-ANA-05080 The FOS shall compute statistics for each analog telemetry parameter for the mission to-date.

F-ANA-05090 The FOS shall compute statistics for each data base defined derived parameter for the mission to-date.

F-ANA-05100 The FOS shall compute the total number of state changes for each discrete telemetry parameter on a daily basis.

F-ANA-05110 The FOS shall compute the total number of state changes for each discrete telemetry parameter on a monthly basis.

F-ANA-05120 The FOS shall compute the total number of state changes for each discrete telemetry parameter for the life of the mission.

F-ANA-05130 The FOS shall compute the total elapsed time spent in each state for each discrete telemetry parameter on a daily basis.

F-ANA-05140 The FOS shall compute the total elapsed time spent in each state for each discrete telemetry parameter on a monthly basis.

F-ANA-05150 The FOS shall compute the total elapsed time spent in each state for each discrete telemetry parameter for the life of the mission.

F-ANA-05160 The FOS shall generate and store statistics for the following FDF supplied data:

a. EOS Brouwer-Lyddane Elements
b. Oscillator Frequency Report
c. Mass and Center of Mass Location Estimates

F-ANA-05170 The FOS shall compute the following statistics for the FDF supplied data:

a. Minimum value
b. Time for the minimum value
c. Maximum value
d. Time for the maximum value
e. Mean
f. Standard Deviation
g. Number of samples

F-ANA-05180 The FOS shall compute statistics for the FDF data upon receipt of the data.

F-ANA-05190 The FOS shall compute statistics for the FDF data for the mission to-date.

8.5.2 User Selectable Statistics

The FOS will allow the user to select their own criteria for generation of statistical data. This request for analysis would require the data to be retrieved from the archive and the statistics to be calculated based upon the user request.

F-ANA-05210 The FOS shall provide the capability to generate the following statistics for each telemetry parameter specified in the request:

a. Minimum value
b. Spacecraft time for the minimum value
c. Maximum value
d. Spacecraft time for the maximum value
e. Mean value
f. Standard deviation
g. Number of samples

F-ANA-05220 The FOS shall provide the capability to compute the statistics for a user defined interval of greater than or equal to one second and less than or equal to one day.

F-ANA-05250 The FOS shall compute statistics for a given parameter if the telemetry item is updated within that interval.

8.6 Algorithms and Special Processing

The FOS will be able to process data based upon user supplied algorithms or system defined algorithms. The user defined algorithms will be accepted into the FOS via the User Interface.

F-ANA-06020 The FOS shall provide the capability to curve-fit a parameter to a polynomial of user specified order, up to order 9.

F-ANA-06021 The FOS shall provide the capability to apply a Fast Fourier Transform (FFT) to a parameter.

F-ANA-06022 The FOS shall provide the capability to smooth a parameter by a user specified factor. Smoothing means that every N data points, where N is the user specified factor, are averaged to yield a single data point.

F-ANA-06023 The FOS shall provide the capability to compute the Root Mean Square (RMS) of a parameter.

8.6.2 Spacecraft Monitoring

F-ANA-06030 The FOS shall provide algorithms for monitoring and evaluating spacecraft functions, resources, and performance including:

a. stored command processing
b. spacecraft recorders
c. safe mode processes
d. electrical power subsystem

e. propulsion subsystem

f. guidance and navigation

g. C&DH

h. communication

8.6.3 User Supplied Algorithms

F-ANA-06040 The FOS shall provide the capability to apply a user supplied algorithm to data maintained in the telemetry archive.

Note: The User algorithms shall be written in the 'C' or 'C++' language and be compiled and linked into a data object appropriate for dynamic linking on the target platform.

F-ANA-06045 The FOS shall provide the capability of allowing up to 20 input parameters and 20 output parameters for a user supplied algorithm.

F-ANA-06050 The FOS shall provide the capability to utilize data contained within a dataset as input into a user supplied algorithm.

8.7 Real Time Analysis

8.7.1 EDOS/NCC Statistics

The FOS shall provide the capability to analyze EDOS and NCC performance data received during real time.

F-ANA-07010 The FOS shall provide the capability to perform MMM statistics on EDOS and NCC data received during real time.

F-ANA-07020 The interval for NCC/EDOS statistics shall be equal to the duration of the real time pass during which the statistics are performed.

F-ANA-07030 The FOS shall provide the capability to process a request for EDOS/NCC statistics for any time span greater than one second and less than three (3) months.

Note: The statistical data generated by the FOS shall not be available until after the real time pass during which it was generated.

8.7.2 Spacecraft Clock Drift Error Calculation

Spacecraft clock values are used for spacecraft position and attitude calculations, antenna and instrument pointing references, and stored command execution. Without accurate clock references, these functions would be degraded. The FOS shall provide the capability to estimate the spacecraft clock error by two different methods.

8.7.2.1 Perform RDD Spacecraft Clock Correlation

The Return Data Delay (RDD) method for calibrating the spacecraft clock with the UTC will be used in addition to the USCCS method (see Section 8.7.2.2). The RDD uses the ground receipt time, spacecraft time, numerous database defined delays, and predicted spacecraft range data to calculate the spacecraft clock error. The method is available during real-time processing of

telemetry, but at a reduced accuracy when compared with the USCCS method. During GN, DSN and non-coherent SN support, the RDD method is the only method which can be used.

F-ANA-07110 The FOS shall provide the capability to calculate the spacecraft clock error by use of the RDD algorithm.

F-ANA-07120 The FOS shall use predicated spacecraft data as input to the RDD algorithm.

F-ANA-07130 The FOS shall interpolate or extrapolate to the nearest millisecond the predicted spacecraft range data.

F-ANA-07140 The FOS shall use the Return Channel Time Delay (RCTD) measurement as input to the RDD algorithm.

Note: The NCC RCTD message format is Performance Data Message type 92, Message Class 62 (OPM-62). This format can be examined in 530-ICD-NCCDS.

F-ANA-07150 The FOS shall collect a maximum of 99 data samples for the RDD algorithm.

Note: The represents one (1) full time delay message, containing 99 return channel time delay groups.

F-ANA-07160 The FOS shall provide notification once per minute indicating the average clock delta value for the RDD method.

Note: Notification shall only be provided during a real-time contact during which the RDD algorithm is being performed.

F-ANA-07180 The FOS shall provide the capability control RDD clock correlation operations.

8.7.2.2 USCCS Spacecraft Clock Correlation

The FOS supports the User Spacecraft Clock Calibration System (USCCS) method for calibrating the spacecraft clock with the ground system UTC. The USCCS algorithm uses TDRSS PN ranging epochs. By measuring the times a PN range epoch left the WSGT and then returned, the time that the PN pulse arrived at the spacecraft can be determined.

When the PN range epoch pulse arrived at the spacecraft, the spacecraft clock value is encoded into the downlink telemetry stream. This value is extracted by the FOS and, after correction for numerous constant equipment delays, is compared with the time the PN pulse arrived at the spacecraft. The difference in this comparison is the spacecraft clock error, which is used to correct spacecraft clock. The USCCS method is available only during coherent two-way tracking SN service. In addition, the USCCS method will perform calculations only after service termination.

F-ANA-07210 The FOS shall provide the capability to calculate the spacecraft clock error by use of the USCCS method.

Note: Both the spacecraft and the SN must be configured for a SN coherent two-way tracking service in order to collect USCCS data.

F-ANA-07215 The EOC shall provide the capability to maintain the spacecraft clock error to an accuracy of 100 microseconds.

F-ANA-07220 The EOC shall collect Time Transfer Messages (TTM) for use by the USCCS method.

Note: The NCC time transfer message format is Performance Data Message type 92, Message Class 66 (OPM-66). This format can be examined in 530-ICD-NCCDS.

F-ANA-07230 The EOC shall, for the USCCS method, collect a maximum of 1275 data samples.

Note: This represents five (5) full time transfer messages, each containing 255 time sample groups.

F-ANA-07240 The EOC shall provide telemetry data filtering capabilities for use with the USCCS method.

Note: Data filtering criteria include requiring coherent mode (from housekeeping telemetry) and spacecraft transponder lock (from CLCW).

F-ANA-07250 The EOC shall perform USCCS calculations following the receipt of all tracking service Time Transfer Messages and the termination of the SN coherent two-way tracking service.

F-ANA-07260 The EOC shall provide a notification that identifies the clock error for the USCCS method.

F-ANA-07280 The EOC shall provide the capability to control USCCS clock correlation operations.

8.7.2.3 Spacecraft Clock Correlation Reports

Spacecraft clock reports shall contain important information on the results of clock correlation for each real-time contact during which clock correlation is performed.

F-ANA-07300 The EOC shall provide the capability to generate a clock correlation report for each real-time pass during which clock correlation is performed.

F-ANA-07310 The EOC shall provide the following header information in the clock correlation report:

a. The start and stop times of the pass during which the correlation was performed

b. The Spacecraft ID

c. The type of calculation used. (USCCS or RDD)

F-ANA-07320 The EOC shall include in the clock correlation report the results from the clock correlation calculation, and the spacecraft time associated with the results.

F-ANA-07330 The EOC shall compute the S/C master oscillator frequency a bias and drift rate from the result of the clock correlation, and include these values in the report.

8.7.3 Spacecraft Activity Log Monitoring

The spacecraft activity log contains a information about the activity which has occurred during the back orbit. Portions of this log may appear in telemetry, but many of the messages in the log will not be visible unless the log is downlinked.

F-ANA-07400 The EOC shall monitor housekeeping telemetry and provide notification if parts of the spacecraft activity log are not visible to the FOT via the housekeeping telemetry stream.

F-ANA-07410 The EOC shall, in the event parts of the spacecraft activity log are not visible in telemetry, generate a command request for downlink of the spacecraft activity log.

8.8 Performance and Status

The FOS will manage all requests for data analysis. This management includes the simultaneous processing of multiple requests as well as the management of a queue of requests waiting to be processed. The FOS will also provide information to the user on the status of a particular request.

F-ANA-08010 The FOS shall provide the capability to process up to TBD simultaneous requests for data analysis

F-ANA-08020 The FOS shall provide the capability to maintain a queue of up to 10 requests for data analysis.

F-ANA-08030 The FOS shall provide the capability to delete a request from the queue.

F-ANA-08040 The FOS shall provide the capability to estimate the percentage complete of a data analysis request.

F-ANA-08050 The FOS shall provide the capability to report the status of a data analysis request. The status can be one of the following:

a. Request submitted

b. Request waiting in queue

c. Request currently being processed

d. Request complete

F-ANA-08060 The FOS shall provide the capability to selectively decommutate only those parameters which are required to fulfill the analysis request.

F-ANA-08070 The FOS shall provide the capability to process a routine request for analysis at 12 time the real time telemetry rate.

Note: A routine request for analysis is defined to be a request for telemetry and statistics from telemetry for up to 1500 mnemonics. This performance requirement applies to the time period starting when telemetry data begins flowing to the analysis request processor, and ending when the resulting dataset is passed on the User Interface for display. This requirement applies only to requests which do not require telemetry which is stored at a location other than the local EOC telemetry archive.

8.9 Expert Advisor

The EOC will be able to detect faults in spacecraft performance and recommend corrective action to the user. This capability will allow the user to create and update definitions of spacecraft faults and corrective actions, so that changes to the spacecraft over the mission life can be accommodated. In order to accomplish this, the concept of a Expert Advisor State Equation(EASE) is introduced. The EASE will be used to indicate a possible situation on the spacecraft which requires attention.

F-ANA-09010 The EOC shall define an EASE to contain up to 15 comparisons of the following type, all resulting in a value of TRUE or FALSE:

a. Spacecraft or ground telemetry value (Greater Than, Less Than, Greater Than or Equal To, Less Than or Equal To, Equal To, Not Equal To) Constant.

   Example. BattVolt1 > 20.0

b. Spacecraft or ground telemetry value (Greater Than, Less Than, Greater Than or Equal To, Less Than or Equal To, Equal To, Not Equal To) spacecraft or ground telemetry value.

   Example. BattVolt1 > BattVolt2

c. The return value of a function taking a ground or spacecraft telemetry value as an argument (Greater Than, Less Than, Equal Greater Than or Equal To, Less Than or Equal To, To, Not Equal To) Constant.

   Example. AverageDeltaValue (BattVolt1) == 0.0

d. The value of another EASE (Equal To) TRUE / FALSE.

   Example. BatteryEASE == TRUE

F-ANA-09020 The EOC shall compute the value of the EASE by operating on the TRUE/ FALSE results of each comparison contained within the EASE, using AND or OR boolean operators.

Examples: (Batt1Volts > 20.0) AND (Battery1EASE == FALSE)

(Batt1Volts > Batt2Volts) OR (Batt2Volts > Batt3Volts)

F-ANA-09030 The EOC shall evaluate the boolean AND/OR operators in order, unless parentheses are included to indicate order of operation.

F-ANA-09040 The EOC shall provide the capability to define an EASE

F-ANA-09050 The EOC shall provide the capability to delete an EASE.

F-ANA-09060 The EOC shall provide the capability to edit an EASE.

F-ANA-09070 The EOC shall provide the capability to define, for each EASE, a text description of the EASE.

Note: A text description is intended to describe the situation indicated by the EASE, as well as add any meaningful information required by the user.

Example: The high gain antenna gimbal drive motor halted due to excessive temperature, greater than 70 celcius. This usually occurs when the spacecraft orients itself with the HGA assembly in line with the sun.

F-ANA-09080 The FOS shall, when an EASE evaluation result is TRUE, display the text description (if defined) of the EASE.

F-ANA-09090 The EOC shall provide the capability to define, for each EASE, a text description of recommended procedures to follow when the EASE evaluation result is TRUE.

F-ANA-09100 The EOC shall, when an EASE evaluation result is TRUE, display the text description of the recommended procedures (if defined) associated with the EASE.

F-ANA-09110 The EOC shall provide the capability to associate a command request with an EASE.

F-ANA-09120 The EOC shall generate the associated command request (if defined) when an EASE evaluation result is TRUE.

F-ANA-09130 The EOC shall provide the capability to associate a real time procedure with an EASE.

F-ANA-09140 The EOC shall initiate the associated real time procedure (if defined) when an EASE evaluation result is TRUE.

F-ANA-09150 The EOC shall provide the capability to evaluate up to 50 EASEs during real time.

F-ANA-09160 The EOC shall provide the capability to evaluate up to 50 EASEs during a replay.

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9. Support Services

Section 9 contains the requirements associated with subsystems that provide services used for the three FOS activity phases. This includes the User Interface subsystem and the Data Management subsystems.

9.1 User Interface Subsystem

The user interface subsystem is responsible for the human-machine interface for the EOC and IST workstations. This includes displaying telemetry, providing means for users to request analysis and other processing, displaying the results of the requests, providing commanding interfaces, as well as providing a host of user tools such as electronic mail, context sensitive help, and a document reader.

This section is organized as follows:

9.1.1 FUI General

9.1.1.1 Screen Management

The FOS provides the users the ability to manage their user desktop environment. This is accomplished using rooms and windows. A room is a collection of windows. A room has three states: default, tiled and user modified. The default state is the normal view of the room. The tiled state is an alternate or cleaned up state. The user modified state is established as a result of a user repositioning and resizing windows in a room. The user will specify the windows contained in a room as well as the default and tiled positions of the windows. The user will be able to move from one room to another dynamically. The user will be able to resize and reposition windows in a room. The user will be able to add and delete windows in a room. A room will have the same appearance when it is entered, as it did when it was left.

F-FUI-01100	The FOS shall provide access to all room definitions in the system.
F-FUI-01105	The FOS shall provide the capability to define a room.
F-FUI-01110	The FOS shall provide the capability to modify a room.
F-FUI-01115	The FOS shall provide the capability to save a room.
F-FUI-01120	The FOS shall provide the capability to delete a room.
F-FUI-01125	The FOS shall allow a room to consist of 0 to 12 windows, with their respective sizes and positions in their default, tiled and user modified states.
F-FUI-01130	The FOS shall allow a window to belong to more than one room.
F-FUI-01135	The FOS shall allow windows to overlap each other.
F-FUI-01140	The FOS shall allow a window to have a name.
F-FUI-01145	The FOS shall provide the capability to define the default position and size of each of the windows in a room.
F-FUI-01150	The FOS shall provide the capability to define the tiled position and size of each of the windows in a room.
F-FUI-01155	The FOS shall provide the capability to add windows to a room dynamically.
F-FUI-01160	The FOS shall provide the capability to delete windows from a room dynamically.
F-FUI-01165	The FOS shall provide the capability to switch from one room to another dynamically.
F-FUI-01170	The FOS shall provide the capability to dynamically reposition windows in a room.
F-FUI-01175	The FOS shall provide the capability to dynamically resize windows in a room.
F-FUI-01180	The FOS shall provide the capability for a user to dynamically switch between room states.

F-FUI-01185 The FOS shall provide the capability to specify the border colors for windows displaying real-time, playback, simulated, event history and multiple source data for all users.

Notes: Rooms will not interfere with the host computer's window manager. Rooms will not interfere with other processes running on the host computer.

9.1.1.2 User Customization

The user will be able to customize those parts of his environment that are common to all windows and rooms. User customization provides the user a personalized environment. This will include such items as default printer, default data directories, type of screen snap, default color intensities for real-time windows, default colors for non real-time windows, default font styles, and default room definitions.

F-FUI-01200 The FOS shall provide the capability to specify the default printer.

F-FUI-01205 The FOS shall provide the capability to specify the default data directories within the system.

F-FUI-01210 The FOS shall provide the capability to specify the default type of screen snap to perform, which includes:

a. snap a printer

b. snap to a file

F-FUI-01215 The FOS shall provide the capability to specify the default color intensities for the real-time windows.

F-FUI-01220 The FOS shall provide the capability to specify the default colors for non real-time windows.

Note: The selection of colors will be from a predefined palette as defined in the ECS User Interface Style Guide.

F-FUI-01225 The FOS shall provide the capability to select the default font styles to be used from a predefined selection.

F-FUI-01230 The FOS shall provide the capability to modify the quick access room selections in the control window.

F-FUI-01235 The FOS shall**,** upon user login**,** load the following default settings:

a. default printer

b. default data directories

c. default screen snap

d. default real-time color intensities

e. default window colors

f. default font styles

g. default room selections

9.1.1.3 Manipulation

The FOS will provide users the capability to manage their user desktop environment using a combination of input devices. Pointing devices such as the mouse and keyboard provide the user flexibility for data input. Additional data input mechanisms may be provided in the future as the state of the art in computer hardware and technology evolves. This may include speech recognition, track ball input, virtual reality interaction, etc.

F-FUI-01305 The FOS shall contain a command line area that allows the user to issue directives from a workstation keyboard.

Note: Detailed requirements for the directives are discussed in section 9.1.1.5.

F-FUI-01310 The FOS shall provide a command line editing capability that allows the retrieval and display of the 20 most recent input lines for modification and resubmission.

F-FUI-01315 The FOS shall allow the user access to the following capabilities:

a. user specified rooms
b. a list of available rooms
c. a list of available windows
d. additional tools (i.e., environment setup)
e. procedures

F-FUI-01320 The FOS shall provide an area that displays the three most recent event messages sent to the user.

F-FUI-01325 The FOS shall enable the user to filter event messages according to the type of event.

F-FUI-01330 The FOS shall allow the user to initiate functions from a control window using a pointing device.

F-FUI-01335 The FOS shall allow the user to perform typical windowing desktop control with the pointing device, including:

a. window focus selection
b. window movement
c. window resizing
d. window closing
e. window iconifying

Note: The FOS intends on providing an "undo" capability where applicable.

F-FUI-01340 The FOS shall allow the user to initiate functions using function keys.

9.1.1.4 User Authentication

The FOS will provide security login procedures to authenticate EOC and IST users.

F-FUI-01400 The FOS shall provide a login screen that allows a user to enter a user name and password.

F-FUI-01405 The FOS shall allow a user to specify a user type (e.g., CAC, OLE, PI/TL, etc.) for the current login session.

F-FUI-01410 The FOS shall allow a user to have one or more user types.

Note: A user may be specified as only one user type at any given time.

F-FUI-01415 The FOS shall allow a user to switch to an alternate user type during a session.

Note:Users will be assigned one or more user types by the PI/TL (IST sites) or EOC Manager (EOC). A user may switch between these assigned user types during a session.

F-FUI-01420 The IST shall provide the capability for a PI/TL to enter a list of authorized IST users.

F-FUI-01425 The EOC shall provide the capability for an EOC Manager to enter a list of authorized EOC users.

Note: The available EOC user types will be: operations coordinator, ops controller/shift supervisor, ground controller, spacecraft activity controller, instrument evaluator/controller, spacecraft evaluator, flight systems engineer, spacecraft engineer, instrument engineer, mission planner/ supervisor, command management analyst, spacecraft planner, instrument planner, ground systems engineer, system specialist, database manager, and software maintenance engineer.

F-FUI-01430 The IST shall provide the capability for a PI/TL to delete IST users from the system.

F-FUI-01435 The EOC shall provide the capability for an EOC Manager to delete EOC users from the system.

F-FUI-01440 The IST shall provide the capability for a PI/TL to change the user types for IST users in the system.

F-FUI-01445 The EOC shall provide the capability for an EOC Manager to change the user types for EOC users in the system.

9.1.1.5 Command Language

The FOS will implement a command language that users will employ to build directives and procedures to support EOC and IST operations. These operations include commanding, monitoring, and analysis of the spacecraft and instruments, controlling and monitoring the ground system configuration, and manipulating the user's workstation environment. Spacecraft and instrument commanding will be governed by a ground script, which consists of time-stamped, time-ordered directives. The ground script can be augmented by the use of preplanned procedures or individual directives that may be manually invoked by users with commanding authority. Local directives, which affect only the user's workstation (e.g., display a telemetry window, initialize the desktop, etc.), are also carried out via procedures or directives that may be executed by all users.

The following requirements define the command language functionality that will be used within FOS to build directives and procedures.

F-FUI-01500 The FOS shall perform a syntax check of all directives entered by the user.

F-FUI-01505 The FOS shall notify the user of directive syntax errors.

F-FUI-01510 The FOS shall allow a user to specify values within a directive in any of the following formats:

a. decimal
b. hexadecimal
c. octal
d. binary
e. string
f. floating point
g. scientific notation
h. time
i. angles

F-FUI-01515 The FOS shall allow a user to specify a conditional construct within a procedure.

Note: Conditional constructs include a switch-case structure and an if-then-else structure.

F-FUI-01520 The FOS shall allow the nesting of conditional constructs.

F-FUI-01525 The FOS shall allow a user to specify iterative loop constructs within a procedure. The loop constructs shall include:

a. while loop (test condition prior to entering loop)
b. until loop (test condition at the end of the loop)
c. for loop (includes an initialization expression, a conditional expression used to terminate the loop, and a loop expression that is executed at the end of each loop iteration)

F-FUI-01530 The FOS shall allow the nesting of loop constructs.

F-FUI-01535 The FOS shall be capable of prematurely terminating conditional loop execution (i.e., procedure execution jumps to the first directive following the end of the loop).

F-FUI-01538 The FOS shall allow a procedure to reference telemetry parameters.

Note: This includes spacecraft and ground telemetry.

F-FUI-01540 The FOS shall allow a user to specify temporary variables within a procedure.

F-FUI-01545 The FOS shall allow a user to specify temporary variable arrays within a procedure.

F-FUI-01550 The FOS shall allow a user to specify comments within a procedure.

F-FUI-01555 The FOS shall allow a user to define labels within a procedure.

F-FUI-01560 The FOS shall allow a user to specify a jump to a labeled statement within a procedure.

F-FUI-01565 The FOS shall allow procedures to invoke other procedures.

F-FUI-01570 The FOS shall allow a procedure to accept arguments when invoked.

F-FUI-01580 The FOS shall provide a directive that allows a user to execute a standard UNIX shell command.

Note: The directive will allow a user to execute a single UNIX command (e.g., cp, rm, etc.). A user may execute a group of commands by creating a shell script and invoking it with the directive.

F-FUI-01585 The FOS shall provide arithmetic and logical operators for use within procedures. These operators are identified in the following table. Operator precedence is listed from highest to lowest.

Note: Operators within the same precedence level will be evaluated from left to right.

Table 9.1.1.5-1. Directive Operators (1 of 2)

Operator	Function	Arity	Precedence
++	Increment variable	unary	1
--	Decrement variable		
!	Logical NOT		
~	Bitwise complement	unary	2
-	Arithmetic negation		
+	Unary plus		
*	Multiplication		
/	Division	binary	3
%	Modulus		
+	Arithmetic addition	binary	4
-	Arithmetic subtraction		
<<	Left shift	binary	5
>>	Right shift		
<	Less than		
<=	Less than or equal to		

Table 9.1.1.5-1. Directive Operators (2 of 2)

Operator	Function	Arity	Precedence
>	Greater than	binary	6
>=	Greater than or equal to		
==	Equality		
!=	Inequality		
&	Bitwise AND	binary	7
^	Bitwise exclusive OR	binary	8
|	Bitwise inclusive OR	binary	9
&&	Logical AND	binary	10
||	Logical OR	binary	11
//	Concatenation	binary	12

F-FUI-01590 The FOS shall allow the use of parentheses to group arithmetic and logical operations within a directive.

Note: Parentheses have the highest precedence during the evaluation of arithmetic and logical operations.

F-FUI-01591 The FOS shall provide built-in functions for use within a directive. These functions are defined in the following table.

Table 9.1.1.5-2. ECL Built-In Functions (1 of 2)

Function Name	Description
acos	trigonometric arc cosine function
asin	trigonometric arc sine function
atan	trigonometric arc tangent function
cos	trigonometric consine function
sin	trigonometric sine function
tan	trigonometric tangent function
cosh	hyperbolic consine function
sinh	hyperbolic sine function
tanh	hyperbolic tangent function
exp	exponential function

Table 9.1.1.5-2. ECL Built-In Functions (2 of 2)

Function Name	Description
log	natural logarithm function
log10	base-10 logarithm function
pow	power function
sqrt	nonnegative square root function
fabs	returns the absolute value

F-FUI-01595 The FOS shall initiate a directive within .5 seconds.

9.1.1.6 Window Requirements

All windows (except temporary windows known as dialog boxes) in the FOS user interface will share a suite of basic capabilities. These capabilities will include such things as window output, colors and font styles.

F-FUI-01600 The FOS shall provide the capability to specify the type of screen snap to perform, which includes:

a. snap to a printer

b. snap to a file

F-FUI-01605 The FOS shall provide the capability to snap a window.

F-FUI-01610 The FOS shall provide the capability to specify the color intensities for the real-time windows.

F-FUI-01615 The FOS shall provide the capability to specify the colors for non real-time windows.

Note: The selection of colors will be from a predefined palette as defined in the ECS User Interface Style Guide.

F-FUI-01620 The FOS shall provide the capability to select the font styles to be used from a predefined selection.

9.1.2 Tools

9.1.2.1 Quick Message Generator

The FOS will provide the capability for users to quickly notify one another by generating quick message events. The quick message locations include all FOS workstations at the EOC and the IST sites. The following requirements define the functions that the FOS will provide with the quick message generator.

F-FUI-02100 The FOS shall allow a quick message to contain a maximum of 240 characters.

F-FUI-02110 The FOS shall visually delineate emergency quick messages from information and warning quick messages.

F-FUI-02115 The FOS shall provide the following message types:

a. emergency
b. warning
c. information

9.1.2.2 Data Mover

The FOS will provide the capability for users to transfer files that contain spacecraft, instrument, and ground system information. The transfer locations include the EOC and the IST sites. The FOS will also provide the capability for users to manage their local file space. The following requirements define the functions that the FOS will provide with the Data Mover.

F-FUI-02200 The FOS shall allow the user to send files from a user station or server.

F-FUI-02202 The FOS shall allow users to delete files from their local storage area.

F-FUI-02205 The FOS shall allow the user to request files to be sent from other FOS user station or server.

F-FUI-02210 The FOS shall allow the user to select files from available categories.

F-FUI-02215 The FOS shall provide a find capability for selecting files.

Note: The find capability allows the user to type in text, and highlights the closest alphabetic candidate.

F-FUI-02220 The FOS shall provide a method to select multiple files to be sent to multiple destinations.

F-FUI-02225 The FOS shall provide a view of selected files to be sent.

F-FUI-02230 The FOS shall provide a list of candidate destinations from which to select the destinations for the file transfer.

F-FUI-02235 The FOS shall allow the user to deselect files that were selected.

F-FUI-02240 The FOS shall provide a notification to the user that:

a. a file transfer is in progress
b. a file transfer has been completed
c. a file transfer error has occurred

9.1.2.3 Replay Controller

The FOS will provide the capability to control the replay of archived telemetry data. The following requirements describe the functions to be provided by the FOS for the replay controller.

F-FUI-02300 The FOS shall provide the user the capability to select a time range for the telemetry data to play, including:

a. start time
b. stop time
c. begin time

Note: The start time and the stop time are used for specifying the time range for requesting the telemetry data. Once the start and stop times for the replay have been set, a user can specify the begin time (other than the start time) for the replay sequence within the time range.

F-FUI-02305 The FOS shall provide the user the capability to select the replay rate.

F-FUI-02310 The FOS shall provide the means of stepping forward through the telemetry data by specifying the amount of time in seconds.

F-FUI-02315 The FOS shall allow the user to pause the replay of the telemetry data sequence.

F-FUI-02320 The FOS shall allow the user to resume the paused replay of the telemetry data sequence.

F-FUI-02325 The FOS shall provide the user the capability to reset the begin time when the replay is in pause mode.

F-FUI-02330 The FOS shall provide a visual indication of the location of the replay data. This display will include:

a. start time

b. stop time

c. position of current time

F-FUI-02335 The FOS shall provide the user a reset capability that will reset the replay time to the last established begin time.

9.1.2.4 Document Reader

The FOS will provide the user with the capability to browse on-line documentation, including user guides, operational procedures, instrument commands, and spacecraft and instrument technical documents. The following requirements describe the document reader functions to be provided by the FOS.

F-FUI-02400 The FOS shall allow the user to browse on-line technical documentation.

F-FUI-02410 The FOS shall provide a document reader with a search capability.

F-FUI-02415 The document reader shall provide the following navigational schemes:

a. hypertext forward

b. hypertext trace back

c. page forward

d. page backward

e. jump to home page (table of contents)

f. search/find on a keyword

Note: Hypertext trace back provides the ability to bring up pages that the user previously viewed.

F-FUI-02420 The FOS shall provide the user with the capability to cancel document retrieval requests.

F-FUI-02425 The FOS shall provide the user with the capability to open one or more document reader windows.

F-FUI-02430 The FOS shall provide a history trace window that will keep track of where the user has been throughout a document viewing session.

F-FUI-02435 The FOS shall provide the user with the capability to clear the document reader history trace window.

F-FUI-02440 The FOS shall provide the capability to input a document.

F-FUI-02445 The FOS shall provide the capability to update a document.

F-FUI-02450 The FOS shall provide the capability to delete a document.

Note: The capability to input, update, and delete a document will be procedurally limited to the FOT document manager.

9.1.2.5 E-Mail

The FOS will provide the user with the capability to send and receive mail electronically. The transfer locations include the EOC and the IST sites. The following requirements define the functions that the FOS will provide with the electronic mail (e-mail) tool.

F-FUI-02500 The FOS shall provide an electronic mail (e-mail) capability.

F-FUI-02505 The FOS shall allow the user to send an e-mail message to multiple destinations**.**

F-FUI-02510 The FOS shall allow a destination to be designated either:

a. a user

b. a position

c. a site

F-FUI-02515 The FOS shall allow the user to attach a file to an e-mail message.

F-FUI-02520 The FOS shall provide the user a simple editor for composing an e-mail message.

F-FUI-02525 The FOS shall provide the user the following e-mail editing capabilities:

a. cut

b. copy

c. paste

d. delete

e. undo

F-FUI-02530 The FOS shall provide the user a method for replying to an e-mail message that was sent.

F-FUI-02535 The FOS shall allow the user to list all received messages.

F-FUI-02540 The FOS shall allow the user to save an e-mail message.

F-FUI-02545 The FOS shall allow the user to delete an e-mail message.

F-FUI-02550 The FOS shall provide the user the following e-mail viewing capabilities:

a. view previous message

b. view next message

c. find a message by:

1. date/time
2. author
3. subject keyword search

9.1.2.6 Display Builder

The FOS will provide the user with the capability to define a real-time display. The following requirements define the functions that the FOS will provide with the display builder.

F-FUI-02600 The FOS shall provide the user a palette of available widgets from which the user may dynamically build a real-time display.

F-FUI-02605 The FOS shall allow the user to drag widgets via the pointing device from the palette and drop them into the display.

F-FUI-02610 The FOS shall provide a palette that shall include:

a. label

b. field

c. (deleted)

d. (deleted)

f. graph

g. table

h. (deleted)

i. (deleted)

j. (deleted)

k. data source

l. (deleted)

m. (deleted)

n. horizontal separator

o. vertical separator

p. schematic graphic items (point, line, icon, circle, rectangle, ellipse, and polygon)

F-FUI-02625 The FOS shall allow the user to associate a telemetry value place holder and a descriptor/mnemonic place holder with a telemetry value.

F-FUI-02630 The FOS shall allow the user to save a real-time display definition as:

a. a local copy, and/or

b. a submission to the FOS CCB as permanent, global copy.

F-FUI-02635 The FOS shall allow the user to modify an existing real-time display definition.

F-FUI-02640 The FOS shall allow the user to delete a real-time display definition.

Note: Temporary alphanumeric, table, and graph displays can be automatically defined and used immediately through the quick analysis capability. See Section 9.1.9.4 for the detailed quick analysis requirements.

9.1.2.7 Help

The FOS will provide the user with the capability to obtain context sensitive hypertext help from any FOS window in the user interface. The following requirements describe the functions to be provided by the FOS for help.

F-FUI-02700 The FOS shall allow the user to browse on-line help documentation.

F-FUI-02705 The FOS shall provide the user with the capability to cancel any help data retrieval.

F-FUI-02710 The FOS shall provide the user with the capability to open one or more help windows.

F-FUI-02715 The FOS shall provide the user with the capability to request help information from any FOS window.

F-FUI-02720 The FOS shall provide the user a help screen that displays help information pertinent to the display or activity the user is involved in when the user requests help.

F-FUI-02725 The FOS shall provide a help screen with the following navigational schemes:

a. hypertext forward
b. hypertext trace back
c. page forward
d. page backward
e. jump to home page (table of contents)
f. search/find on a keyword

Note: Hypertext trace back provides the ability to bring up help pages that the user previously viewed.

9.1.2.8 Procedure Builder

The FOS provides the user with the capability to create, edit, store, print, and delete preplanned procedures. These procedures typically contain directives that are related to a single function (e.g., directives to safe an instrument). The FOS will provide standard editing capabilities coupled with FOS-specific functions, such as procedure syntax checking and requests for command validation. A command builder function will also be provided with the editor to assist the user in constructing directives. The command builder will present lists of valid directive components (e.g., directive keyword, mnemonic descriptors, etc.) that a user may select and insert into the procedure text. The

following requirements define the procedure building capability that will be provided by the FOS. The term authorized user indicates that the user must either be the owner (i.e., creator) of the procedure or have system administrator privileges.

F-FUI-02800 The FOS shall provide a user the capability to create procedures.

F-FUI-02805 The FOS shall provide an authorized user the capability to edit existing procedures.

F-FUI-02810 The FOS shall provide a user the capability to save procedures according to one of the following procedure types:

a. emergency
b. command
c. ground
d. local
e. activity
f. user-defined categories

Note: The following procedure types will be implemented for FOS:

Emergency - a procedure that contains command directives that perform an emergency operation (e.g., safe an instrument). The policy for classifying a procedure as an emergency procedure will be determined by the FOT.
Command - a non-emergency procedure that contains at least one command directive.
Ground - a procedure that contains at least one ground system directive.
Local - a procedure that contains no command or ground system directives.
Activity - a procedure created as part of a Planning and Scheduling activity definition
User-defined - a category type defined by the user.

F-FUI-02815 The FOS shall provide a user the capability to save a procedure according to its spacecraft identifier.

F-FUI-02820 The FOS shall provide a user the capability to save a procedure according to its instrument identifier.

Note: A procedure may be saved according to both its spacecraft and instrument identifiers (e.g., AM-1, CERES-Aft).

F-FUI-02825 The FOS shall provide a user the capability to identify the author of each procedure.

F-FUI-02830 The FOS shall verify that the procedure directives are consistent with the procedure type, except for user-defined procedures, when a save operation is attempted.

Note: For example, a procedure containing a command directive cannot be saved as a local procedure. No consistency checking will be performed for procedures saved under a user-defined category.

F-FUI-02835 The FOS shall provide an authorized user the capability to delete existing procedures.

F-FUI-02840 The FOS shall provide a user the capability to print existing procedures.

F-FUI-02845 The FOS shall provide a user the following procedure editing capabilities:

a. cut/copy/paste text
b. delete text
c. insert text
d. search for text strings
e. replace text strings
f. insert an existing procedure

F-FUI-02850 The FOS shall be capable of checking the syntax of a procedure.

F-FUI-02855 The FOS shall display the current procedure syntax check status.

Note: The syntax and validation status indicators will be saved with the procedure text when a save operation is performed.

F-FUI-02860 The FOS shall provide a user the capability to request validation of procedures.

Note: Procedures will be validated by the Command Management Subsystem (see Section 6.2). Validation status, including all errors detected, will be returned to the FUI Subsystem and displayed to the user.

F-FUI-02865 The FOS shall display the current procedure validation status.

Note: The syntax and validation status indicators will be saved with the procedure text when a save operation is performed.

F-FUI-02870 The FOS shall display a list of directive keywords that the user may select from to build procedure directives.

F-FUI-02875 The FOS shall display a list of directive keyword qualifiers that the user may select from to build procedure directives. The qualifier list will correspond to the selected keyword.

F-FUI-02880 The FOS shall display a list of mnemonics descriptors that the user may select from to build procedure directives.

F-FUI-02885 The FOS shall display a list of mnemonic qualifiers that the user may select from to build procedure directives.

Note: The qualifier list will correspond to the selected discrete mnemonic descriptor.

F-FUI-02890 The FOS shall display a set of current limit values that the user may select from to build procedure directives.

Note: The set of limit values will correspond to the selected analog mnemonic descriptor.

F-FUI-02895 The FOS shall provide a user the capability to insert the following items into the procedure text:

a. directive keywords
b. directive keyword qualifiers
c. mnemonics
d. mnemonic qualifiers (for mnemonics with discrete values)
e. limit identifiers (for mnemonics with analog values)

Note: Four limit values will be displayed: high-red, high-yellow, low-yellow, and low-red. If the user selects one of these, a corresponding identifier (i.e., a symbolic constant such as HIGH-RED) will be inserted into the procedure. This will allow the procedure to reference the proper limit value from the project data base when the procedure is executed.

9.1.2.9 Reports

9.1.2.9.1 Report Template Builder

The FOS provides the user with the capability to define templates for the automatic creation of reports. A report template can consist of anything from a simple ASCII text file that is imported, to a collection of off-line analysis products of predefined telemetry values and blocks of predefined descriptive text. This removes the burden of repetitious report generation from the user.

F-FUI-02920 The FOS shall provide the capability to create a custom report template composed of the following information:

a. ASCII files
b. off-line analysis products
c. screen snaps
d. blocks of descriptive text
e. other routine reports

F-FUI-02925 The FOS shall provide the following routine report templates:

a. statistical reports
b. power performance
c. propulsion performance
d. instrument performance
e. anomaly reports
f. memory comparison report
g. memory image report
h. memory map report
i. event history report
j. down link ordered report

k. parameter out-of-limits report

F-FUI-02950 The FOS shall provide the capability to save a report template.

F-FUI-02955 The FOS shall provide the capability to modify an existing report template.

F-FUI-02960 The FOS shall provide the capability to delete a report template.

F-FUI-02961 The FOS shall provide the capability to specify the report margins.

F-FUI-02962 The FOS shall provide the capability to specify the report fonts.

F-FUI-02963 The FOS shall provide the capability to specify the report title.

F-FUI-02964 The FOS shall provide the capability to specify a default destination for the completed report (file, printer, browser/editor).

F-FUI-02965 The FOS shall provide the capability to specify report author name.

9.1.2.9.2Report Generation

The report generation service takes a report generation request as input and produces a report. This report can then be saved as a file, sent to the printer, or viewed using the report browser/editor.

F-FUI-02967 The FOS shall provide the capability to create a report from a custom or routine report template.

F-FUI-02970 The FOS shall provide the capability to accept report generation requests.

F-FUI-02975 The FOS shall provide the capability to insert a specified file into a report.

F-FUI-02980 The FOS shall provide the capability to insert a specified off-line analysis product into a report.

F-FUI-02985 The FOS shall provide the capability to insert a specified screen snap into a report.

F-FUI-02990 The FOS shall provide the capability to insert predefined blocks of text into a report.

F-FUI-02991 The FOS shall provide the capability to insert routine reports into a report.

F-FUI-02995 The FOS shall provide the capability to save a completed report.

F-FUI-03000 The FOS shall provide the capability to initiate the printing of a completed report.

F-FUI-03005 The FOS shall provide the capability to initiate the report browser/editor with a completed report.

F-FUI-03010 The FOS shall provide the capability to cancel the processing of a report generation request.

9.1.2.9.3 Report Browser/Editor

The report browser/editor allows the user to request a report to be generated from a list of predefined templates, browse and edit existing reports, or invoke the Report Template Builder.

F-FUI-03025 The FOS shall provide the capability to display a list of existing report templates.

F-FUI-03030 The FOS shall provide the capability to display a list of existing reports.

F-FUI-03035 The FOS shall provide the capability to initiate the report template builder with a template selected from the template list for browsing or editing.

F-FUI-03040 The FOS shall provide the capability to initiate the report generator with a template selected from the template list.

F-FUI-03045 The FOS shall provide the capability to select a report from the report list for browsing or editing.

F-FUI-03050 The FOS shall provide the capability to display an existing report.

F-FUI-03055 The FOS shall provide the capability to print an existing report.

F-FUI-03060 The FOS shall provide the capability to edit an existing report.

F-FUI-03061 The FOS shall provide the capability to save an existing report.

Note: COTS products are being considered for the report browser/editor.

9.1.3 Utilities

9.1.3.1 Time Selection

The time selection utility will allow the user to specify a time~~s~~**,** a pair of start and stop times, or a time interval. This utility will be used whenever the user needs to specify time values, such as with off-line analysis, historical tables or graphs, replays, etc. The user will be able to specify the time values either by an absolute time, an orbital event or a relative time, such as the last N hours or the last N orbits. Intervals may be specified according to a specified event (e.g., every n orbits) or time period (e.g., every n hours).

F-FUI-03100 The FOS shall allow the user to choose the start and stop time or an event and duration based on the following:

a. calendar date and time
b. north equator crossing
c. south equator crossing
d. entering orbital day
e. entering orbital night
f. loss of signal
g. acquisition of signal
h. last N hours
i. last N orbits

F-FUI-03105 The FOS shall allow the user to select an epoch.

Note: An epoch would be selected when the user wants to establish a reference point in time. This could be used to establish epochs for data sets from different times, but with similar data. The epochs would be used to "line up" the data at zero time on the graph.

F-FUI-03110 The FOS shall allow the user to specify a time interval based on any of the following:

a. every N passes
b. every N orbits
c. every N hours
d. every N days
e. every N weeks
f. every N months

9.1.3.2 Selection Filter

The Selection Filter will be used in many different areas of the FOS user interface. The user will use this utility for filtering a list of items (such as mnemonics, events, reports, and etc.) for selection according to a specific spacecraft (e.g., AM-1, PM-1, etc.), spacecraft subsystem (e.g., power, communications, etc.), instrument (e.g., MISR, CERES, etc.), or ground system (e.g., NCC, EDOS, ECOM, etc.).

F-FUI-03200 The FOS shall provide a utility that allows a user to filter items according to any of the following:

a. spacecraft
b. spacecraft subsystem
c. instrument
d. ground system

F-FUI-03205 The FOS shall allow the user to specify one or more spacecraft Ids as a filter criteria.

F-FUI-03210 The FOS shall allow the user to specify one or more spacecraft subsystems as a filter criteria.

F-FUI-03215 The FOS shall allow the user to specify one or more instruments as a filter criteria.

F-FUI-03220 The FOS shall allow the user to specify one or more ground systems as a filter criteria.

F-FUI-03225 The FOS shall allow the user to specify one or more subsystems associated with a spacecraft Id as a filter criteria.

F-FUI-03230 The FOS shall allow the user to specify one or more instruments associated with a spacecraft Id as a filter criteria.

9.1.4 Planning and Scheduling

Planning and scheduling user interfaces include: activity builder and editor, master and alternate plan management, resource editor, scheduling tools, subsystem analysis tools, timeline display and map display. The displays and tools will provide graphical views into the various plans and will provide the information needed to do both long and short term planning. It will also allow planners to access historical activity data.

The timeline display is a continuous plan that will start from spacecraft launch and will end at the predicted end of the spacecraft mission. Planners who want to display various stages of the plan will be able to scroll and zoom, by time and resource, through one timeline. The long term portion of the plan will usually be that portion that is beyond the orbit data provided by the FDF. The initial and final scheduling stages will be within the FDF orbit data limits. Historical data will be anything that appears in the past. The software will not force hard boundaries between phases of the plan so that the FOT will have flexibility in refining their own planning cycles.

F-FUI-04000 The FOS shall provide the capability to display a mission schedule for a specified time period on a timeline display.

F-FUI-04010 The FOS shall provide the capability to display TDRSS availability for a specified time period on a timeline display.

F-FUI-04020 The FOS shall provide the capability to display resource usage with 2D line plots or bar graphs on a timeline display.

F-FUI-04030 The FOS shall provide the capability to scroll by time and resource on the timeline display.

F-FUI-04040 The FOS shall provide the capability to zoom in and out by time and resource on the timeline display .

F-FUI-04050 The FOS shall provide the capability to specify mission schedule access permissions on a timeline display.

F-FUI-04060 The FOS shall provide the capability to display orbital events on the timeline display.

F-FUI-04070 The FOS shall provide the capability to display the current date and time on the timeline display.

F-FUI-04080 The FOS shall provide the capability to display the start and end times of activities and events on the timeline display.

F-FUI-04090 The FOS shall provide the capability to display the start and end times of the Detailed Activity Schedule on the timeline display.

F-FUI-04100 The FOS shall provide the capability to highlight activities that violate hard and soft constraints on the timeline display.

F-FUI-04110 The FOS shall provide the capability to display “what-if” changes on the timeline display.

F-FUI-04120 The FOS shall provide the capability to display activities and events on the timeline display.

F-FUI-04130 The FOS shall provide the capability to display the time period that a load is valid for uplink on the timeline display.

F-FUI-04140 The FOS shall provide the capability to display detailed information about activities and events selected from the timeline display.

F-FUI-04280 The FOS shall provide the capability to display the limit of orbit data from the FDF on the timeline.

F-FUI-04290 The FOS shall provide the capability to display the amount of resources allocated to a particular instrument or spacecraft subsystem over time on the timeline.

F-FUI-04300 The FOS shall provide the capability to display the total amount of resources available on a particular spacecraft over time on the timeline.

9.1.5 Command Management

The following sections define the user interface requirements for the FOS Command Management capability. These requirements define a number of displays that assist the user in managing the command management products (i.e., ground scripts and loads). The user may print the contents of each display by requesting either a formatted report or a snapshot of the corresponding display window. Reports may be requested using either a command language directive or the Report Browser/Editor function.

9.1.5.1 Table Load Builder

The FOS will provide the user with a display that will be used to input data for spacecraft and instrument table loads. Once the data has been entered, the user may request the building of a load for subsequent uplink to the spacecraft or instrument. The following requirements define the table load generation capability that shall be provided by the FOS. The term authorized user indicates that the user must have the authority to create spacecraft or instrument tables. Reference Section 6.2 for table generation requirements.

F-FUI-05100 The FOS shall provide an authorized user the capability to enter table data using a pre-defined template.

Note: Each type of table load will have a data base defined template.

F-FUI-05105 The FOS shall provide an authorized user the capability to enter table data into a template using the data from an existing table load.

F-FUI-05110 The FOS shall validate the table data entered by the user.

F-FUI-05115 The FOS shall display any validation errors that are detected.

F-FUI-05120 The FOS shall provide an authorized user the capability to request the generation of a table load.

F-FUI-05125 The FOS shall notify the requester when a table load has been successfully generated.

F-FUI-05130 The FOS shall display any errors encountered during the table load generation process.

9.1.5.2 RTS Load Builder

The FOS will provide the user with an editor that will be used to input data for Relative Time Sequence (RTS) loads. Once the data has been entered, the user may request the building of a load for subsequent uplink to the spacecraft. The following requirements define the RTS load generation capability that shall be provided by the FOS. Reference Section 6.2 for RTS generation requirements. The term authorized user indicates that the user must have the authority to create RTS loads.

F-FUI-05200 The FOS shall allow an authorized user to enter RTS data that will be used to generate an RTS load.

F-FUI-05205 The FOS shall provide an authorized user the capability to request the generation of an RTS load.

F-FUI-05210 The FOS shall display any validation errors detected in the RTS data.

F-FUI-05215 The FOS shall notify the requester when an RTS load has been successfully generated.

F-FUI-05220 The FOS shall display any errors encountered during the RTS load generation process.

9.1.5.3 Ground Script Display

The FOS will provide a display listing the ground scripts that have been generated or executed during the last seven days (minimum). Each ground script may contain critical commands that apply to the spacecraft and its instruments. This display will indicate, for each ground script, if any of the spacecraft subsystems or instruments are affected by critical commands within the ground script. This display will also provide the user the capability to view and approve the contents of a ground script prior to its execution. The following requirements define the ground script display capability that will be provided by the FOS. The term authorized EOC user indicates that the user has been granted authority to review and approve ground scripts containing critical commands. Reference Section 6.2 for the ground script generation requirements.

F-FUI-05300 The FOS shall provide a display listing the ground scripts that have been generated or executed during the last seven days, at a minimum.

F-FUI-05305 The FOS shall display an indication of the instrument(s) affected by critical commands within a ground script.

F-FUI-05310 The FOS shall display an indication of whether any of the spacecraft subsystems are affected by critical commands within a ground script.

F-FUI-05315 The FOS shall provide a user the capability to display the contents of a ground script.

F-FUI-05320 The IST shall provide the PI/TL the capability to approve a ground script containing critical commands that affect the PI/TL's instrument.

F-FUI-05325 The FOS shall provide an authorized EOC user the capability to approve a ground script containing critical commands that affect the spacecraft.

F-FUI-05330 The FOS shall provide an authorized EOC user the capability to override the ground script approval process.

F-FUI-05335 The FOS shall provide a user the capability to print a ground script.

F-FUI-05340 The FOS shall provide a user the capability to print a ground script with expanded procedures.

9.1.5.4 ATC Buffer Display

The FOS will provide the user with a display to view the command-to-memory map of an Absolute Time Command (ATC) buffer. This display will allow the user to highlight commands within the

buffer according to various criteria (e.g., executed commands, commands associated with a specified command inhibit group, etc.). The following requirements define the ATC buffer display capability that will be provided by the FOS. Reference Section 6.2 for ATC load generation requirements.

F-FUI-05400 The FOS shall provide a user the capability to display the command-to-memory map of an ATC buffer.

F-FUI-05405 The FOS shall provide a user the capability to highlight the contents of the ATC buffer according to one or more of the following criteria:

a. executed commands
b. commands awaiting execution
c. commands associated with a specified command inhibit group
d. ATC pseudo-ops
e. critical commands
f. hazardous commands
g. empty areas (no-ops)
h. commands associated with a specific instrument, and
i. commands associated with a specific spacecraft subsystem.

Note: ATC pseudo-ops include commands for the ATC processor (e.g., execute an RTS, jump to a specific location, no-ops, etc.).

9.1.5.5 RTS Buffer Display

The FOS will provide the user with a display to view the map of the Relative Time Sequence (RTS) buffers. This display will allow the user to highlight the RTS buffers according to various criteria (e.g., critical commands, RTS ownership, etc.). In addition, the display will indicate linkages between the RTS buffers. A user may also select an RTS buffer and view its command-to-memory map. The following requirements define the RTS buffer display capability that will be provided by the FOS. Reference Section 6.2 for RTS load generation requirements.

F-FUI-05500 The FOS shall provide a user the capability to display the map of the RTS buffers.

F-FUI-05505 The FOS shall provide a user the capability to highlight the RTS buffers according to one or more of the following criteria:

a. critical commands
b. hazardous commands
c. commands associated with a specific instrument
d. commands associated with a specific spacecraft subsystem
e. RTS ownership
f. undefined RTS

Note: RTS ownership is used to identify an RTS buffer with a specific instrument, subsystem, or function (e.g., FDIR).

F-FUI-05510 The FOS shall provide a user the capability to display RTS linkages.

Note: Linkages indicate the relationship between RTS buffers. One RTS buffer may contain commands invoking other RTS buffers.

F-FUI-05515 The FOS shall provide a user the capability to display the command-to-memory map of an RTS buffer.

9.1.5.6 Load Catalogs

The FOS will provide a display that lists catalog information for each load uplinked or generated during the last seven days (minimum). This catalog information will include the name of the load, the load type (e.g., RTS, ATC, etc.), valid load times, the load source (e.g., MISR), and the load destination (e.g., RTS #2). The Command Activity Controller (CAC) may use this display to generate a load uplink directive for a selected load.

F-FUI-05600 The FOS shall provide a user the capability to display catalog information for each load uplinked or generated during the last seven days, at a minimum.

Note: Catalog information includes:

a load name

b. load type

c. valid load times

d. load source

e. load destination

F-FUI-05605 The FOS shall provide a CAC the capability to generate a load uplink directive for a selected load.

Note: The load uplink directive will be inserted into the command line of the CAC's Command Control Display. The CAC must use the Command Control Display to execute this directive.

9.1.6 Commanding

9.1.6.1 Procedure Control

Users will be able to invoke procedures at a specified time (default is immediately). Once a procedure is active, the user will be able to suspend the procedure, resume a suspended procedure, or terminate the procedure. A user may activate a procedure viewer when executing a non-command procedure (i.e., a procedure that does not contain any spacecraft or instrument commands). This viewer will allow a user to monitor and control the execution of the procedure. The following requirements define the procedure control capability that will be provided by the FOS.

F-FUI-06100 The FOS shall allow an authorized user to invoke a procedure at a specified time.

Note: In general, all users will be authorized to execute local procedures since the directives in this type of procedure only impact the user's

workspace (e.g., display specified pages in the current room). Only a Command Activity Controller may execute a procedure that contains command directives. Such a procedure (e.g., command procedures or emergency procedures) may be merged with the currently executing ground script directives after evaluating its impact with respect to the current commanding activities. Similarly, only specific users will be authorized to execute ground procedures that contain directives to configure the ground system resources.

F-FUI-06105 The FOS shall allow a user to terminate an executing procedure.

F-FUI-06110 The FOS shall allow a user to suspend an executing procedure.

F-FUI-06115 The FOS shall allow a user to resume a suspended procedure.

F-FUI-06120 The FOS shall allow multiple local procedures to execute simultaneously.

F-FUI-06125 The FOS shall allow only one ground system procedure per logical string to execute at any time.

Note: Multiple local procedures may execute simultaneously since the directives in these procedures only affect the user's workstation. Command procedures and emergency procedures, which contain spacecraft or instrument commands, will be merged with the executing ground script directives when they are invoked by the Command Activity Controller. Therefore, only one command procedure can be active at any given time. Similarly, FOS will ensure that only one ground system procedure is active at any time for a logical string in order to avoid conflicts in ground system resource allocation.

F-FUI-06130 The FOS shall provide a display that allows a user to monitor the execution of a non-command procedure invoked from the user's workstation.

Note:This display is activated when the non-command procedure is invoked. A non-command procedure is one that contains no spacecraft or instrument commands. Command procedures can only be executed by a user with command authority and are merged with the currently executing ground script. Users may monitor the execution of a command procedure via the Command Control Display or the Command Monitor Display (reference Section 9.1.6.3).

F-FUI-06135 The FOS shall provide a display that allows a user to control the execution of a non-command procedure invoked from the user's workstation.

Note:This display, which is activated when the procedure is invoked, allows a user to suspend, resume, or terminate the non-command procedure. Command procedures are merged with the ground script directives and are controlled via the Command Control Display (reference Section 9.1.6.3).

9.1.6.2 Command Requests

The FOS provides the capability for authorized users to create and submit command requests to the Flight Operations Team (FOT). In the IST, the authorized users are those who receive

authorization from the PI/TL. In EOC, the authorized users are those who receive authorization from the EOC Manager. Each command request must be evaluated to determine its impact with respect to the current commanding activities (i.e., ground script). The Ops Controller is authorized to accept or reject the request based upon this evaluation. Once a request has been evaluated, the EOC provides the status of the request to the originator. Requests that are accepted are executed by the Command Activity Controller (CAC) at the specified time. The following requirements define the command request capability that will be provided by the FOS.

F-FUI-06200 The FOS shall provide an authorized user the capability to generate a command request that contains:

a. a procedure to execute

b. any instructions that the FOT should follow.

F-FUI-06205 The FOS shall provide an authorized user the capability to send a command request to the Ops Controller.

F-FUI-06210 The EOC shall notify the Ops Controller of pending command requests.

F-FUI-06215 The FOS shall display the status of the pending and accepted command requests. The status display shall contain:

a. request Id

b. request summary

c. status (i.e., accepted, pending)

d. originator

e. date/time received

f. date/time acted upon (accepted or rejected).

g. instrument Id

h. spacecraft Id

Note: A pending status indicates that the command request has not been evaluated. An accepted status indicates that the command request has been approved. Once the CAC merges the command request with the ground script directives, the entry is removed from the status display.

F-FUI-06220 The FOS shall allow a user to display the contents of a command request.

F-FUI-06225 The FOS shall notify the originator when a command request is accepted.

F-FUI-06230 The FOS shall notify the originator when a command request is rejected. This notification shall contain the reason for the rejection.

F-FUI-06235 The EOC shall provide the CAC the capability to merge the command request procedure with the current executing ground script directives.

F-FUI-06240 The EOC shall indicate to the CAC the syntax check status of the procedure referenced in the command request.

F-FUI-06245 The EOC shall indicate to the CAC the validation status of all procedures referenced in the command request.

Note: The originator of a command request will be able to monitor the status of each procedure merged into the ground script via the Command Control Window (see the Command Control requirements that follow).

9.1.6.3 Command Control

The FOS provides the CAC with the capability to control commanding of each spacecraft and its instrument payload. The spacecraft and instrument commanding will be governed by a ground script, which consists of time-stamped, time-ordered directives. The EOC allows the CAC to manipulate execution of the ground script per spacecraft. The FOS also provides the capability for all users to monitor the execution of a ground script. The following requirements define the command control capability that will be provided by the FOS.

F-FUI-06300 The FOS shall display the following information for the active ground script:

a. ground script time frame (UTC start and stop time)

b. ground script status (active or suspended)

c. spacecraft Id

d. (deleted)

e. (deleted)

f. command confirmation mode

g. bias time

F-FUI-06305 The FOS shall allow a user to view executed ground script directives, the current ground script directive, and future ground script directives.

F-FUI-06310 The FOS shall display a count-down timer for the next three directives in the current ground script.

F-FUI-06315 The FOS shall execute local directives encountered in the ground script at the specified execution time.

Note: The current system time may become later than the specified execution time of a directive in the ground script. This situation may occur if the ground script is suspended by the CAC for an extended period of time. If this happens, directives will be executed as quickly as possible until the execution time and the system time are synchronized.

F-FUI-06320 The FOS shall process ground script command directives for the spacecraft and its instruments at the specified execution time.

Note: Processing a command directive includes sending the directive to the Commanding Subsystem where it is prepared for uplink to the spacecraft. The Commanding Subsystem performs the appropriate verification checks and returns the corresponding directive status to the command controller for display to a user.

F-FUI-06330 The FOS shall display the following verification status for command directives depending upon whether the corresponding verification mode is enabled:

a. prerequisite state check pass/fail

b. receipt of command at the spacecraft/instrument pass/fail (command verification)

c. execution of the command by the spacecraft/instrument pass/fail (telemetry verification)

F-FUI-06335 The FOS shall suspend ground script execution if an enabled prerequisite state check fails.

Note: Verification checking only applies to command directives. If the current directive is a local directive, the next directive will become the current directive as soon as the local directive is executed.

F-FUI-06337 The EOC shall provide the capability to request an override of a prerequisite state check failure.

F-FUI-06340 The FOS shall suspend ground script execution if any of the enabled verification checks fail.

F-FUI-06345 The EOC shall provide the CAC the capability to set (on/off) prerequisite state checking.

F-FUI-06350 The EOC shall provide the CAC the capability to set (on/off) command verification checking.

Note: Turning off command verification checking allows execution of the ground script to proceed without waiting for a command verification status. Command verification checking will always be performed.

F-FUI-06355 The EOC shall provide the CAC the capability to set (on/off) telemetry verification checking.

Note: Turning off telemetry verification checking allows execution of the ground script to proceed without waiting for a telemetry verification status. Telemetry verification checking will always be performed.

F-FUI-06360 The EOC shall provide the CAC the capability to select a directive in the ground script.

F-FUI-06365 The EOC shall provide the CAC the capability to disable directives in the ground script.

F-FUI-06370 The EOC shall provide the CAC the capability to enable directives in the ground script.

F-FUI-06375 The EOC shall provide the CAC the capability to transfer execution to a directive in the ground script.

Note: The EOC will allow the user to select a non-executed directive in the ground script and jump to the selected directive after the execution of the current directive is successfully completed.

F-FUI-06380	The EOC shall provide the CAC the capability to apply a bias time to all future directives in the ground script.
F-FUI-06385	The EOC shall provide the CAC the capability to confirm a critical command directive.
F-FUI-06390	The EOC shall provide the CAC the capability to cancel a command directive.
F-FUI-06395	The EOC shall provide the CAC the capability to set (on/off) the command confirmation mode.
F-FUI-06400	The EOC shall provide the CAC the capability to confirm pending commands when command confirmation is enabled.
F-FUI-06405	The EOC shall provide the CAC the capability to cancel pending commands when command confirmation is enabled. Note: The FOS will implement a command confirmation mode. If enabled, this mode will queue each command directive (i.e., place them into a pending command buffer) until the CAC confirms or cancels the directive.
F-FUI-06410	The EOC shall provide the CAC the capability to terminate the current ground script.
F-FUI-06415	The EOC shall provide the CAC the capability to start a ground script.
F-FUI-06420	The EOC shall provide the CAC the capability to suspend execution of the ground script.
F-FUI-06425	The EOC shall provide the CAC the capability to resume execution of the ground script.
F-FUI-06430	The EOC shall provide the CAC the capability to merge procedures with the current executing ground script directives.
F-FUI-06435	The EOC shall provide the CAC the capability to merge a directive with the current executing ground script directives.
F-FUI-06440	The FOS shall provide a user the capability to search the executing ground script for a specified procedure reference.
F-FUI-06445	The FOS shall provide a user the capability to search the executing ground script for a specified command.
F-FUI-06450	The FOS shall provide a user the capability to search the executing ground script for a specified time stamp.
F-FUI-06455	The FOS shall provide a user the capability to search the executing ground script for a specified text string.
F-FUI-06460	The FOS shall provide a user the capability to print the current executing ground script.
F-FUI-06465	The EOC shall save the "as-used" ground script and make it available for future analysis.
F-FUI-06470	The FOS shall display all commands manually input.

Note: This capability is commonly referred to as "command shadowing" by the Flight Operations Team.

9.1.7 Monitor Telemetry

The FOS will provide displays for telemetry data. This telemetry data includes both spacecraft telemetry, instrument telemetry, and ground telemetry. Ground telemetry includes data from external systems such as NCC, EDOS, ECOM, etc.

9.1.7.1 Real-Time Display

All real-time displays, including replay displays, in the FOS user interface will share a suite of basic capabilities. These capabilities will include such things as update rate, access to Quick Analysis, pausing displays and data source selection.

F-FUI-07100 The FOS shall allow the user to select an update rate from 1 to 60 seconds.

F-FUI-07120 The FOS shall allow the user to invoke quick analysis on the selected telemetry parameters.

F-FUI-07125 The FOS shall allow the user to pause the display.

F-FUI-07130 The FOS shall allow the user to resume the display.

F-FUI-07135 The FOS shall label dynamically created displays as temporary.

F-FUI-07140 The FOS shall provide the capability to specify the real-time display data source(s).

Note: Each real-time display can be associated with real-time, replay, and/ or simulation data streams. The user can specify the data source of a telemetry display to be from one or multiple data streams.

9.1.7.2 Alphanumeric Displays

The alphanumeric displays will display telemetry parameters in real-time, updating at a user selectable rate from 1 to 60 seconds. From an alphanumeric display, a user will be able to view discrete and analog telemetry parameters, their data quality and any limit violations. A user will be able to define the format of an alphanumeric display and then save the format for later use.

F-FUI-07200 The FOS shall provide alphanumeric displays that are capable of displaying the following:

a. the descriptor or mnemonic of a telemetry parameter
b. the current state of a discrete telemetry parameter
c. the current value of an analog telemetry parameter
d. the current state of an analog telemetry parameter based on a range of predefined values
e. whether data associated with a telemetry parameter is suspect (bad quality)
f. whether data associated with a telemetry parameter is static
g. whether an analog telemetry value has violated a range limit

h. whether an analog telemetry value has violated a delta limit
i. descriptive labels
j. static descriptive text
k. horizontal and vertical separator lines
l. Universal Time Coordinated (UTC)
m. spacecraft time
n. current orbit number
o. data source (real-time, replay, simulated)
p. current major/minor frame counts
q. current telemetry format
r. current telemetry rate
s. spacecraft Id

F-FUI-07205 The FOS shall allow alphanumeric displays to display one or more telemetry parameters.

F-FUI-07210 The FOS shall load alphanumeric displays dynamically from a predefined format.

F-FUI-07215 The FOS shall allow the user to change a telemetry parameter's label from descriptor to mnemonic.

F-FUI-07220 The FOS shall allow the user to change a telemetry parameter's label from mnemonic to descriptor.

F-FUI-07225 The FOS shall be capable of displaying a telemetry value in the following formats:

a. converted
b. decoded
c. raw

Note: The raw format displays the bit string extracted from the telemetry packet. The decoded format displays the integer representation of the raw value. The converted format displays the value of the parameter after its decoded value has been subjected to a parameter-specific conversion function (e.g., apply a calibration curve to the decode value).

F-FUI-07230 The FOS shall be capable of displaying a telemetry value in one of the following representations:

a. formatted
b. octal
c. hex
d. binary

Note: A formatted representation will either be a string, decimal integer, or floating-point number based upon the parameter type and the specified format.

F-FUI-07235 The FOS shall allow the user to select telemetry parameters by using a pointing device (e.g., mouse, trackball, etc.).

F-FUI-07240 The FOS shall allow the user to deselect telemetry parameters by using a pointing device (e.g., mouse, trackball, etc.) .

F-FUI-07245 The FOS shall allow the user to change the display of selected telemetry values to any of the following formats:

a. converted

b. decoded

c. raw

Note: The raw format displays the bit string extracted from the telemetry packet. The decoded format displays the integer representation of the raw value. The converted format displays the value of the parameter after its decoded value has been subjected to a parameter-specific conversion function (e.g., apply a calibration curve to the decode value).

F-FUI-07250 The FOS shall allow the user to change the display representation of selected telemetry values to one of the following:

a. formatted

b. octal

c. hex

d. binary

Note: A formatted representation will either be a string, decimal integer, or floating-point number based upon the parameter type and the specified format.

F-FUI-07255 The FOS shall prevent a change in the displayed telemetry format when a non-supported format for a particular parameter is requested (i.e., when a decoded format is requested for a ground telemetry parameter).

9.1.7.3 Graphs

The graph will be either a real-time or a historical graph displaying up to six telemetry parameters in an X vs. Y line graph format. The real-time graph will update at a user selectable rate from 1 to 60 seconds. Graphs will consist of either telemetry values vs. time, or telemetry values vs. a telemetry value. The user will be able to interactively modify the view of the graph with the ability to change such things as the title, axis labels, axis granularity, grid granularity and line style, and telemetry parameter symbols and line style.

F-FUI-07300 The FOS shall provide graphs that are capable of displaying the following:

a. up to six telemetry values vs. time, or

b. up to six telemetry values vs. a telemetry value

c. the high and low, red and yellow limits of the telemetry parameters as lines(dotted, dashed or solid)

d. telemetry values as a symbol(optional)

e. lines between telemetry parameters (optional) shall be displayed as dotted, dashed or solid

f. axis lines (displayed or not)

g. axis labels

h. axis scales

i. axis scale labels

j. optional grid lines (dotted, dashed or solid)

k. title

l. current range of time displayed

m. total range of time available

F-FUI-07305 The FOS shall allow the user to select up to six telemetry parameters to graph.

F-FUI-07310 The FOS shall allow the user to plot data from different times and/or different data sources on

a. a two dimensional graph

b. a three dimensional graph

F-FUI-07315 The FOS shall display the minimum, current and maximum values of a selected telemetry parameter within the current visible area of the graph.

F-FUI-07320 The FOS shall allow the user to select a telemetry parameter from the graph utilizing a pointing device.

F-FUI-07325 The FOS shall allow the user to select a range of times or X values, from the total range of time or X values available, in which to view the data.

F-FUI-07330 The FOS shall have the capability to capture all occurrences of a parameter between screen updates, and then display the captured data at the next update.

F-FUI-07335 The FOS shall allow the user to zoom in on the graph.

F-FUI-07340 The FOS shall allow the user to zoom out from the graph.

F-FUI-07345 The FOS shall allow the user to select a line style with which a telemetry parameter is displayed.

F-FUI-07350 The FOS shall allow the user to select a symbol with which a telemetry parameter is displayed.

F-FUI-07355 The FOS shall allow the user to specify whether the graph shall display a grid.

F-FUI-07360 The FOS shall allow the user to specify the grid line style (dotted, dashed or solid).

F-FUI-07365 The FOS shall allow the user to specify the grid granularity.

F-FUI-07370 The FOS shall allow the user to specify which high and low, red and yellow limit lines to display.

F-FUI-07375 The FOS shall allow the user to specify limit line style (dotted, dashed, or solid).

F-FUI-07380 The FOS shall allow the user to select the axis granularity.

F-FUI-07385 The FOS shall allow the user to select the axis scale labels.

F-FUI-07388 The FOS shall allow the user to specify the axis labels.

F-FUI-07390 The FOS shall allow the user to specify the graph title.

F-FUI-07391 The FOS shall allow the user to insert a graph legend.

F-FUI-07392 The FOS shall allow the user to save a graph.

F-FUI-07394 The FOS shall print graphs in either landscape or portrait orientation.

F-FUI-07396 The FOS shall allow the user to print up to 4 graphs per page.

F-FUI-07398 The FOS shall provide the visual indication that a telemetry value does not exist within the requested time span.

9.1.7.4 Tables

The table will display up to 50 columns of real-time and history telemetry values and their associated times. The real-time table will update at a user selectable rate from 1 to 60 seconds. The user will be able to select the time increment for the time column.

F-FUI-07400 The FOS shall provide tables that are capable of displaying the following:

a. up to 50 discrete and analog real-time telemetry values over a specified time interval
b. the associated time at each interval
c. the descriptor or mnemonic of each telemetry value
d. title
e. current range of time displayed

F-FUI-07410 The FOS shall allow the real-time table display to have a maximum of 300 rows of data. Once the maximum has been reached, the oldest rows are removed as newer rows are added.

Note: This will allow for 10 minutes worth data at a 2 second update rate.

F-FUI-07415 The FOS shall provide the user with the capability to specify whether the telemetry value is represented by its mnemonic or descriptor.

F-FUI-07425 The FOS shall provide the user with the capability to capture all occurrences of a telemetry value between screen updates**,** and then display the captured data at the next screen update.

9.1.7.5 Schematics

Two dimensional schematic displays will present telemetry values for both spacecraft and instrument data**,** updating at a user selectable rate from 1 to 60 seconds. A schematic is a representation of data by combining visual items such as rectangles, lines, circles, points, etc. These items can change color according to the telemetry parameter limits.

F-FUI-07500 The FOS shall provide a display of two-dimensional schematic drawings.

F-FUI-07505 The FOS schematic drawings shall contain:

a. points
b. lines
c. icons
d. text
e. circles
f. rectangles
g. ellipses
h. polygons

F-FUI-07510 The FOS shall color code schematic components, changing colors according to the telemetry parameter limits.

F-FUI-07515 The FOS shall drive the color coded schematic components with telemetry values.

F-FUI-07520 The FOS shall provide the user the capability to save a snapshot of the schematic.

F-FUI-07525 The FOS shall provide the user the capability to print a snapshot of the schematic.

9.1.7.6 Info Window

The Info window will display a column of up to 50 telemetry value mnemonics and respective columns of associated data from the Project Data Base (PDB). This data will include cycle locations, valid discrete states, analog conversion polynomials, limits, etc.

F-FUI-07600 The FOS shall display the following PDB information about discrete and analog telemetry parameters:

a. the descriptor
b. the mnemonic
c. the valid states of a discrete telemetry value
d. the conversion polynomial of an analog telemetry value
e. the delta limits for a telemetry value
f. the high and low, red and yellow limits for a telemetry value
g. the cycles from which the telemetry value is extracted
h. the telemetry values on which a derived telemetry value is based

i. parameter Id

j. spacecraft Id

F-FUI-07605 The FOS shall provide the user with the capability to display up to 50 telemetry parameters and their associated data in an Info window.

9.1.7.7 Status Window

The status window will display a fixed set of data, associated with a single logical string, updating at a user selectable rate from 1 to 60 seconds. This window will display Universal Time Coordinated (UTC), spacecraft time, count down clock, current orbit number, data source, current cycle count, current telemetry format, current telemetry rate and spacecraft identifier.

F-FUI-07700 The FOS shall provide a status window that displays:

a. Universal Time Coordinated (UTC)

b. spacecraft time

c. count down clock

d. current orbit number

e. data source (real-time, replay, simulated)

f. cycle count

g. current telemetry format

h. current telemetry rate

i. spacecraft identifier

F-FUI-07710 The FOS shall provide a count down clock. The count down clock will first count down to the acquisition of signal time (AOS). After AOS, it will count down to the loss of signal time (LOS).

F-FUI-07720 The FOS shall provide one status window for each logical string connection.

9.1.7.8 Solid State Recorder Analysis Window

The Solid State Recorder (SSR) analysis window will display SSR buffer data in real-time. This will include SSR buffer pointers, SSR buffer status, SSR playback state, and RF failures that impact SSR playbacks. The SSR analysis window will also display recommended recovery procedures to correct for playback loss and RF fault links, provided by the analysis subsystem. These requirements are mission specific.

9.1.8 Resource Management

The FOS will provide the capability for a user to submit resource service requests to the Resource Management Subsystem (RMS). A resource service request, which will be initiated as part of a request to perform real-time telemetry and command processing, spacecraft simulation, or replay of historical telemetry, is used by RMS to connect the user's workstation to a logical string. Users will be able to establish connections to multiple logical strings in order to concurrently monitor activities from different data sources (e.g., real-time and replay telemetry).

The FOS will provide the capability to display and monitor ground system configuration data. This data will include ground system equipment status, ground system parameter values (i.e., ground system mnemonics), and workstation configuration data. The ground system equipment status and ground system parameter values will be presented to the user in a format similar to the telemetry displays described in Section 9.1.7. Ground system events will be displayed to the user via the FOS event display (see Section 9.1.10).

The FOS will provide the capability for an authorized user to control the ground system equipment. This capability will be implemented via FOS command language directives. The specific processing requirements for the Resource Management Subsystem are defined in Section 7.1. The following requirements define the resource management user interface capability that will be provide by the FOS.

F-FUI-08100 The FOS shall provide a user the capability to submit a resource service request.

Note: A resource service request will contain the parameters needed by the Resource Management Subsystem to establish a logical string. These parameters include:

a. spacecraft Id

b. data base Id

c. service type (real-time, replay, simulation)

d. mode (operational, training, test)

F-FUI-08105 The FOS shall provide a user the capability to display ground system equipment status.

F-FUI-08110 The FOS shall provide a user the capability to display ground system parameter values.

F-FUI-08115 The FOS shall provide a user the capability to display user workstation configuration data.

Note: The workstation configuration display will show the connections between each active workstation and the established ground system configurations.

9.1.9 Analysis

9.1.9.1 Analysis Requests

The FOS provides the capability to perform analysis in support of spacecraft operations. The analysis functions provided include trend analysis, performance analysis, anomaly detection and spacecraft monitoring. Analysis functions will be performed using real-time and historical spacecraft data. The FOS will allow the user to build an analysis request based upon analysis selections. The following requirements define the user interface that provides the user the ability to build analysis requests.

F-FUI-09100 The FOS shall provide the capability to build an off-line analysis request that contains the following:

a. spacecraft Id
b. spacecraft subsystems
c. telemetry parameters
d. time period
e. sampling rates
f. data filters
g. frequency intervals
h. output views
i. output view formats
j. pre-defined algorithms
k. request name

Note: Output view formats are defined in section 9.1.9.2.

F-FUI-09105 The FOS shall provide the capability to select a sampling rate per selected telemetry parameter when building an analysis request for historical data analysis. Sampling rates shall be one of the following:

a. all data
b. changes only
c. every Nth sample when N = a specified number

F-FUI-09110 The FOS shall provide the capability to select statistical data per selected TLM parameter when building an analysis request for historical data analysis. Statistics shall be one of the following:

a. system generated
b. min-max reduced, with a specified interval in minutes

F-FUI-09112 The FOS shall provide the capability to specify a parameter for input to an algorithm when building an analysis request for historical data analysis. Algorithms can be one of the following:

a. user-defined
b. system supplied

F-FUI-09115 The FOS shall provide the capability for an analysis request to be submitted using the standing order process.

Note: Standing orders are described in section 9.1.9.3.

F-FUI-09120 The FOS shall provide the capability to modify a stored analysis request and resubmit it as a new request.

F-FUI-09125 The FOS shall provide the capability for a user to save an analysis request.

F-FUI-09130 The FOS shall provide the capability for a user to delete a stored analysis request.

F-FUI-09140 The FOS shall provide the capability to display a request queue of up to 10 submitted analysis requests.

Note: The request queue will display the following data for each request:

a. request name

b. estimated completion time of requests gathering archived/local data.

c. estimated completion time for the decom processing of requests. (if applicable)

F-FUI-09145 The FOS shall provide the capability to assign priority to a pending request in the request queue.

Note: Requests with the same priority will be processed on a FIFO basis.

F-FUI-09150 The FOS shall provide the capability to delete a request from the request queue display.

F-FUI-09160 The FOS shall provide the capability to select output products for a completed request from the request queue display.

F-FUI-09170 The FOS shall provide the capability to display an analysis request.

F-FUI-09180 The FOS shall provide the capability to print an analysis request.

9.1.9.2 Analysis Results

The FOS will provide the capability to display off-line analysis results in several different output views**.** The FOS will allow the user to modify the output format for the analysis output view.

F-FUI-09200 The FOS shall provide the capability to display off-line analysis results in the following output views:

a. graph (see 9.1.7.3 for graph requirements)

b. table (see 9.1.7.4 for table requirements)

c. analysis report (see section 9.1.2.9 for report requirements)

F-FUI-09205 The FOS shall provide the capability to save analysis results.

F-FUI-09210 The FOS shall provide the capability to print analysis results.

F-FUI-09215 The FOS shall provide the capability to save analysis output view formats.

F-FUI-09220 The FOS shall provide the capability to modify analysis output view formats. Format options include the following:

a. engineering units

b. raw values

c. time

F-FUI-09225 The FOS shall provide the capability to use existing data sets as input for analysis requests.

9.1.9.3 Standing Orders

9.1.9.3.1Standing Order Manager

The standing order manager will provide users with the ability to perform repetitive analysis activities automatically. The user will specify a start and stop date, request interval, number of hours of data to analyze, telemetry analysis request**s** and report templates. The standing order manager will automatically issue the telemetry analysis and/or report requests from the start date to the stop date, at the specified interval. For each request, the standing order manager will receive the telemetry analysis data set and initiate the processing of the requested analysis output products and/or reports.

F-FUI-09300 The FOS shall accept and process analysis requests containing at a minimum:

a. date/time to start processing the request

b. date/time to stop processing the request

c. request interval (every n passes, every n orbits, every n hours, every n days, every n weeks, every n months)

d. telemetry analysis request**s**

e. report templates

f. request name

g. name of the person who submitted the request

F-FUI-09305 The FOS shall generate telemetry analysis requests and/or report requests at the specified request interval from the start date to the stop date.

F-FUI-09310 The FOS shall receive the associated telemetry analysis data sets, at each request interval, and will initiate the generation of the output products based on the telemetry analysis and/or report requests.

F-FUI-09315 The FOS shall produce status for executing standing orders.

9.1.9.3.2Standing Order Browser

The standing order browser will allow users to view all standing orders in the system. The user will be able to view the status of a standing order, as well as suspend, resume and delete standing orders.

F-FUI-09350 The FOS standing order browser shall provide information on standing orders including, at a minimum:

a. request name

b. next interval start time

c. standing order status (i.e. active, halted, processing, completed)

d. name of person who submitted the request

F-FUI-09355 The FOS standing order browser shall provide the capability to sort the standing orders by the following criteria including at a minimum:

a. request name

b. next interval start time

c. standing order status

d. name of person who submitted request

F-FUI-09360 The FOS shall allow the user to view the results of a completed standing order analysis request using the Analysis Product Selector and/or the Report Browser/Editor.

F-FUI-09363 The FOS shall allow an authorized user to modify the standing order's interval.

F-FUI-09365 The FOS shall enable an authorized user to suspend a standing order.

F-FUI-09370 The FOS shall enable an authorized user to resume a standing order.

F-FUI-09375 The FOS shall enable an authorized user to delete a standing order.

Note: The author, CAC, or PI/TL would be the only users authorized to suspend, resume or delete a standing order.

9.1.9.4 Quick Analysis

The FOS provides the capability to access analysis functions for real-time telemetry data. The Quick Analysis function allows the user to select telemetry points and output views. Telemetry point selections will be based on the real-time telemetry data. The analysis results will be displayed in the selected output view. Several output views will be provided to view the analysis results. The analysis results will be used to monitor and evaluate the performance of the spacecraft and the instruments.

F-FUI-09410 The FOS shall provide the following output views for real-time analysis requests:

a. alphanumeric telemetry

b. real-time graph

c. real-time table

d. info window

Note: requirements for alphanumeric telemetry displays are in 9.1.7.2, real-time graphs in 9.1.7.3 and real-time tables in 9.1.7.4.

F-FUI-09415 The FOS shall provide the capability to build an analysis request on real-time data that contain the following:

a. spacecraft Id

b. spacecraft subsystem/instrument

c . telemetry parameters

d. real-time output views

e. output view formats

9.1.9.5 Algorithm Registration

The FOS will provide the capability for users to supply algorithms for the monitoring and evaluation of spacecraft functions, resources and performance. Algorithms will be defined using the C programming language. The FOS shall provide a user interface for the registering of algorithms. Registered algorithms will be available for use when the user builds the analysis request.

F-FUI-09500 The FOS shall provide the capability to register an algorithm that contains the following:

a. algorithm name

b. algorithm object file name

c. output parameter name

d. input parameters

F-FUI-09510 The FOS shall provide the capability to select a registered algorithm per selected parameters when building an analysis request.

F-FUI-09515 The FOS shall provide the capability to select valid discrete and analog values to be used per algorithm.

9.1.10 Data Management

9.1.10.1 Event Display

The FOS will provide users the ability to view real-time events, request event history, view event history, and filter events by event type. Additional capabilities will be to browse, select and print reports.

F-FUI-09600 The FOS shall display informational text messages about events that occur at EOC, ISTs, S/C and instruments.

F-FUI-09605 The FOS shall provide a filter capability for the real-time event and event history displays that allows events to be included**,** excluded**,** or highlighted according to:

a. spacecraft Id

b. ground system

c. instrument

d. spacecraft subsystem

e. event message type

f. time period

Note: Valid event message types are delineated in the archive requirement's section, 9.2.2.

F-FUI-09610 The event display shall have a scrolling text field that displays the current event messages.

F-FUI-09615 The event display shall contain a graphical timeline that displays one indicator per event.

F-FUI-09620 The graphical timeline event indicators shall be color coded per event type.

F-FUI-09625 As a user scrolls through the event text, the graphical timeline shall display a time correlated visual indicator.

F-FUI-09630 As a user selects an event in the graphical timeline, the event text shall scroll to the corresponding event.

F-FUI-09635 The FOS shall allow the user to search for event messages that contain specific textual content.

F-FUI-09640 The FOS shall provide the results of an event history request in the event history display.

F-FUI-09645 The FOS shall visually alert a user that an event has occurred.

F-FUI-09650 The FOS shall allow the user to activate and deactivate the generation of auditory alarms associated with the occurrence of events.

9.1.10.2 Event History Request

The FOS will provide the users with the ability to take requests pertaining to event history and exhibit them in the event display.

F-FUI-09700 The FOS shall provide the user with the capability to request event history data.

F-FUI-09705 The event history request shall include filtering of events by:

a. time period
b. spacecraft Id
c. instrument
d. spacecraft subsystem
e. event message type

F-FUI-09710 The FOS shall provide the user with the capability to store the results of the event history request for future analysis.

9.2 Data Management Subsystem

The Data Management Subsystem is responsible for supporting FOS mission operations. This function is performed through four types of services; data base generation, file management, event processing, and ground telemetry generation. This section provides the detail level requirements necessary to perform these services.

This section is organized as follows:

9.2.1 Project Data Base

The EOC will provide a Project Data Base (PDB) containing information necessary to support FOS mission operations. Telemetry, command, activity and constraint definitions will be maintained within this PDB. These definitions will be governed by the formats specified in the FOS PDB Data Format Control Document (DFCD). The input definitions will be loaded into the FOS PDB where they may be edited, validated, accessed for viewing and report generation and then once regarded as acceptable this information will be made available for operational use. The operational data is used by the application software to support telemetry processing and spacecraft commanding.

9.2.1.1 PDB Inputs

The EOC will receive from the spacecraft contractor, the PIs and the FOT, the telemetry, command, activity and constraint definitions. These definitions will be maintained within the PDB and be used in support of FOS mission operations.

F-DMS-00110 The EOC shall accept housekeeping and engineering telemetry definitions.

F-DMS-00120 The telemetry definitions shall contain the following information:

a. telemetry packet processing definitions
b. discrete telemetry definitions
c. discrete state definitions - up to 16 ranges for each discrete parameter
d. analog telemetry definitions
e. red/yellow, delta limit definitions - up to four limit sets for each parameter may be defined
f. linear engineering unit conversion definitions - up to four linear sets specified with up to 15 point pairs for each analog parameter
g. polynomial engineering unit conversion definitions - up to four polynomial sets with up to the 7th order equations for each analog parameter
h. derived parameter definitions - up to five input parameters in an equation
i. context dependent definitions - up to 16 ranges may be specified for each parameter
j. subsystem/instrument definitions

F-DMS-00130 The EOC shall accept spacecraft and instrument command definitions.

F-DMS-00140 The command definitions shall contain the following information:

a. spacecraft command definitions
b. instrument command definitions
c. command criticality
d. telemetry verification
e. prerequisite state checking
f. command conversion instructions
g. memory mapping definitions
h. table definitions
i. stored command indicator

F-DMS-00150 The EOC shall accept spacecraft and instrument activity definitions.

F-DMS-00160 The activity definitions shall contain the following information:

a. command listing
b. parameter mapping definition
c. parameter limit definitions

Note: Activity definitions are used in support of planning & scheduling and command management

Note: Activities may contain real-time commands, stored commands, ECL directives, and command procedure names.

Note: This includes label activities (i.e., activities that don't have commands associated with them).

F-DMS-00170 The EOC shall accept spacecraft and instrument constraint definitions.

F-DMS-00180 The constraint definitions shall contain the following information:

a. spacecraft constraint definitions

b. instrument constraint definitions

c. operational mode transition definitions

d. command timing and sequencing constraints

Note: Telemetry, command, activity and constraint definitions are governed by the formats specified in the FOS PDB Data Format Control Document (DFCD).

Note:Command timing and sequencing constraints are performed at the subsystem/instrument level and at the command level.

9.2.1.2 PDB Edit

The EOC will provide an edit capability to allow additions, deletions and modifications of the definitions maintained in the PDB. Authorized users will be allowed to perform these editing functions. As part of the data base generation process, validation is performed whenever changes have been made to the contents of the PDB.

F-DMS-00205 The EOC shall provide authorized users the capability to add telemetry definitions to the PDB.

Note: Authorized users are those persons given data base privileges such as the data base administrator.

F-DMS-00210 The EOC shall provide authorized users the capability to delete telemetry definitions maintained in the PDB.

F-DMS-00215 The EOC shall provide authorized users the capability to modify telemetry definitions maintained in the PDB.

F-DMS-00220 The EOC shall provide authorized users the capability to add command definitions to the PDB.

F-DMS-00225 The EOC shall provide authorized users the capability to delete command definitions maintained in the PDB.

F-DMS-00230 The EOC shall provide authorized users the capability to modify command definitions maintained in the PDB.

F-DMS-00235 The EOC shall provide authorized users the capability to add activity definitions to the PDB.

F-DMS-00240 The EOC shall provide authorized users the capability to delete activity definitions maintained in the PDB.

F-DMS-00245 The EOC shall provide authorized users the capability to modify activity definitions maintained in the PDB.

F-DMS-00250 The EOC shall provide authorized users the capability to add constraint definitions to the PDB.

F-DMS-00255 The EOC shall provide authorized users the capability to delete constraint definitions maintained in the PDB.

F-DMS-00260 The EOC shall provide authorized users the capability to modify constraint definitions maintained in the PDB.

F-DMS-00265 The EOC shall provide a PDB edit log presenting edits made to the PDB.

F-DMS-00270 The EOC PDB log shall include the following information:

a. Time stamp
b. PDB version number
c. File name
d. User ID
e. Changes made to the PDB since the last update

Note: Last update refers to the last time the user made changes to the current version of the PDB.

9.2.1.3 PDB Validation

The EOC will provide validation of the definitions maintained in the PDB. Validation will include syntax-checking, verification of values and cross-validation of related information. The PDB will be validated whenever changes are made to its content. Once completed, the validated definitions will be available for accessing and reporting and may be provided for operational use. The validated PDB definitions which have been made available for operational use cannot be edited.

F-DMS-00310 The EOC shall provide the capability to perform validation on the telemetry definitions maintained in the PDB.

F-DMS-00320 The EOC shall provide the capability to perform validation on the command definitions maintained in the PDB.

F-DMS-00330 The EOC shall provide the capability to perform validation on the activity definitions maintained in the PDB.

F-DMS-00340 The EOC shall provide the capability to perform validation on the constraint definitions maintained in the PDB.

F-DMS-00350 The EOC shall provide the capability to generate a validation report which contains summary and error information.

F-DMS-00360 The EOC shall provide the capability to perform validation on modifications to the PDB definitions.

9.2.1.4 PDB Reporting

The FOS will provide read-only examination of the PDB. This will allow users to access and report information stored in the PDB.

F-DMS-00410 The FOS shall provide for authorized users the capability to report information maintained in the PDB.

F-DMS-00420 The FOS shall provide the capability to access PDB information for reporting purposes by the following:

a. PDB type (telemetry, command, activity, constraint)

b. mnemonic

9.2.1.5 PDB Backup, Restore and Compare

The EOC will perform periodic backup and restores of the PDB.

F-DMS-00510 The EOC shall maintain all versions of the operational PDB.

Note: The operational PDB refers to the PDB definitions which have been validated and regarded as acceptable for operational use.

F-DMS-00520 The EOC shall maintain the following information for each version of the PDB:

a. PDB version number

b. effective date

F-DMS-00530 The EOC shall provide the capability to backup the operational PDB.

F-DMS-00540 The EOC shall provide the capability to restore the operational PDB.

F-DMS-00550 The EOC shall provide the capability to compare two versions of the validated PDB.

9.2.1.6 Operational Data Base Generation

The EOC will generate data base files to support FOS mission operations. Inputs into this process will include validated PDB definitions.

F-DMS-00610 The EOC shall provide for operational use of the telemetry PDB definitions.

F-DMS-00620 The EOC shall provide for operational use of the command PDB definitions.

F-DMS-00630 The EOC shall provide for operational use of the activity PDB definitions.

F-DMS-00640 The EOC shall provide for operational use of the constraint PDB definitions.

F-DMS-00650 The operational data shall contain a version number and date of generation.

9.2.2 File Management

The EOC will provide for the archival and retrieval of telemetry data, non-telemetry data, events data, and file data. All archived data will be maintain a minimum of 7 days at the EOC. Archived data is sent to SDPS for long term storage.

9.2.2.1 Telemetry Archive

The EOC will provide the capability to archive and retrieve telemetry data associated with each spacecraft. A seamless telemetry archive will be created by merging real-time and playback telemetry.

F-DMS-00710 The EOC shall archive all telemetry data.

F-DMS-00720 The EOC shall maintain the telemetry data on-line for a minimum of 7 days.

F-DMS-00730 The EOC shall archive telemetry in chronological order.

F-DMS-00740 The EOC shall merge new telemetry packets with existing packets to create a seamless archive.

Note: Real-time and non real-time playback telemetry will be merged to create a seamless archive.

F-DMS-00750 The EOC shall insure that the telemetry archive does not contain duplicate data.

F-DMS-00760 The EOC shall replace existing poor quality telemetry packets with good quality telemetry packets.

F-DMS-00770 The FOS shall provide the capability to retrieve archived telemetry by specifying the following:

a. Spacecraft start time
b. Spacecraft stop time
c. Data source (Ground station)
d. Data type (housekeeping, engineering)
e. Spacecraft Identifier (if applicable)

F-DMS-00780 The FOS shall provide the capability to replay archived telemetry at user selectable rates.

Note:Reference User Interface Subsystem Section 9.1.2.3.

F-DMS-00790 The EOC shall initiate processing of off-line telemetry data from the EOC archive within 5 seconds upon receipt of a telemetry request.

Note: If a telemetry request is delayed due to process load, then this requirement applies when processing the telemetry request is started (e.g., if other concurrent telemetry requests are made).

Note: Reference level 3 requirement DADS-3125 for performance requirements for long-term data.

9.2.2.2 Ground-Telemetry Archive

The EOC will provide the capability to archive and retrieve ground-telemetry data. The ground-telemetry archive will consist of NCC and EDOS data.

F-DMS-00810 The EOC shall archive all ground-telemetry data.

F-DMS-00820 The EOC shall maintain the ground-telemetry data on-line for a minimum of 7 days.

F-DMS-00830 The EOC shall archive ground-telemetry in chronological order.

F-DMS-00840 The FOS shall provide the capability to retrieve archived ground-telemetry by specifying the following:

a. Spacecraft start time

b. Spacecraft stop time

c. Data source (NCC,EDOS)

d. Data type

e. Spacecraft Identifier (if applicable)

9.2.2.3 Events Archive

The EOC will be capable of archiving and retrieving events associated with each spacecraft. Event messages will be retrieved by specifying time, event identifier, event type, spacecraft identifier, and instrument identifier.

F-DMS-00910 The EOC shall archive all event messages.

Note: Duplicated events will not be archived (i.e. telemetry limit events from multiple workstations).

F-DMS-00920 The EOC shall maintain events data on-line for a minimum of 7 days.

F-DMS-00930 The FOS shall provide the capability to retrieve archived events by specifying the following:

a. UTC start time

b. UTC stop time

c. Event type(s)

d. Event identifier

e. Spacecraft Identifier (if applicable)

f. Instrument Identifier (if applicable)

F-DMS-00940 The EOC shall retrieve event messages in chronological order.

9.2.2.4 File Archive

The EOC will be capable of storing, retrieving, and providing configuration control of data files in support of operations.

F-DMS-01010 The EOC shall be capable of storing data files.

F-DMS-01020 The EOC shall be capable of retrieving data files.

Note: The EOC will store and retrieve the following data files:

a. Absolute time command loads

b. Relative time sequence loads

c. Spacecraft memory dumps

d. Instrument memory dumps

e. Flight software loads

f. Microprocessor loads

g. Ground scripts

h. Memory images

i. Spacecraft memory maps
j. Load reports
k. Integrated load report
l. Schedules
m. Procedures
n. Display definitions
o. Room definitions
p. Report formats
q. User configuration defaults
r. Analysis request files
s. Operator guides
t. Operator procedures
u. Spacecraft technical documentation
v. Orbit statistics
w. Daily statistics
x. Monthly statistics
y. EOS mission star catalog
z. EOS Brouwer-Lyddane elements
aa. Long term science plans
bb. Long term instrument plans
cc. Long term spacecraft operations plan
dd. Orbit data
ee. Instrument activity lists
ff. Spacecraft subsystem activity lists
gg. TDRSS Schedules
hh. Oscillator frequency report
ii. Onboard navigation evaluation report
jj. Filter tuning parameters
kk. Mass and center of Mass location estimates
ll. NCC configuration codes
mm. Planning Aids

9.2.2.5 Long-Term Archive

The EOC shall provide archived data to the SDPS for long term storage. Archived data consists of telemetry data, events data, plans and schedules, operations data, and configuration data.

F-DMS-01110 The EOC shall provide the capability to send archived data to a designated SDPS.

F-DMS-01120 The EOC shall accept storage status, indicating the success or failure of the storage of the archived data, from the SDPS.

F-DMS-01130 The EOC shall maintain the archived data until the SDPS has notified the EOC of successful storage.

F-DMS-01140 The EOC shall provide the capability to retrieve FOS archive data from the SDPS.

F-DMS-01150 The EOC shall provide 2 days of storage for staging long-term telemetry data.

Note: This requirement will be used for disk sizing. Long-term telemetry data is data that is retrieved from the SDPS.

9.2.3 Event Message Processing

The FOS will process and display all event messages. The event message will be formatted to include UTC time tag, event type, event identifier, event message, spacecraft identifier(if applicable), and instrument identifier(if applicable). The FOS provides the capability to set event filters, define event triggers, and toggle the alarm characteristic of an event.

F-DMS-01210 The FOS shall provide the capability to generate event messages.

F-DMS-01220 The FOS event messages shall include the following:

a. UTC time tag
b. Event type
c. Event Identifier
d. Event message
e. Spacecraft Identifier (if applicable)
f. Instrument Identifier (if applicable)

F-DMS-01230 The FOS shall provide the capability to filter event messages by:

a. UTC time tag
b. Event type
c. Event Identifier
d. Spacecraft Identifier (if applicable)
e. Instrument Identifier (if applicable)

F-DMS-01240 The EOC shall provide the capability to initiate a procedure based on an event.

Note: Only selected events will have this capability.

F-DMS-01250 The FOS shall provide the capability to designate a type of event message as an alarm.

Note:This requirement is for local events.

F-DMS-01260 The FOS shall provide the capability to designate a type of event message as not an alarm.

Note:The alarm characteristic of an event is removed.

Note:This requirement is for local events.

F-DMS-01270 The FOS shall provide the capability to generate events upon receipt of hardware component status change information from the MSS.

F-DMS-01280 The FOS shall provide the capability to generate events upon receipt of permanent and temporary software component status change information from the MSS.

9.2.4 Ground Telemetry

The EOC will generate definition files used to support ground telemetry. Ground telemetry is used by the EOC to support system operations. Inputs to these definition files will be provided by the software developers.

F-DMS-01310 The EOC shall provide the capability to input ground telemetry definitions.

Note: Ground telemetry consists of EDOS, NCC and user defined definitions.

Note: This requirement allows for status information to be displayed for EDOS, NCC, and user defined ground telemetry.

Note: Examples of user defined ground telemetry are number of workstations, prime and backup information, and string information.

F-DMS-01320 The EOC shall provide the capability to validate ground telemetry definitions.

Note: Ground telemetry consists of EDOS, NCC and user defined definitions.

F-DMS-01330 The EOC shall provide for operational use of validated ground telemetry definitions.

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